W. Gover

AN ESSAY Of the Great EFFECTS OF Even Languid and Unheeded MOTION.

Whereunto is Annexed

An Experimental Diſcourſe of ſome little obſerved Cauſes of the Inſalubrity and Salubrity of the Air and its Effects.

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OF THE

Publiſher.

'TIS *thought fit the Reader ſhould be inform'd, That the inſuing Tract (about the* Effects of Languid Motions) *was deſign'd to be a Part of the Authour's Notes about the* Origine of Occult Quali-

ties, *and ſhould have come abroad together with the Papers about the* Effluvia of Bodies *(moſt of which are already publiſh'd.) And accordingly it was printed ſeven or eight years ago: which Circumſtance is here mention'd, to give a Reaſon why ſeveral Particulars were omitted in the Body of the Diſcourſe, that will be found annex'd to the End of it. For theſe occurring to the Authour whilſt he curſorily read over the Tract it ſelf, when it*

it was upon the point to be made publick, 'twas thought fit rather to subjoin them by way of a short Appendix, *than to let any thing be lost that seem'd pertinent to so difficult and uncultivated a Subject, as That they belong to. The Reader is farther to be advertis'd, That of the* Three Preliminary Discourses, *which the Authour intended for Introductory Ones to What he design'd to say more particularly about the* Mechanical Origine or Pro-

Advertiſement of Production of Occult Qualities, One *was concerning the* Relations betwixt the Pores of Bodies and the Figures of Corpuſcles: *but that the great Intricacy and Difficulty He found in this copious Subject, made Him conſent, That the* Diſcourſe of Local Motion, *which ſhould have accompany'd it to the Preſs, ſhould be printed long before it. And thoſe Papers about* Pores and Figures *having been for a great while out*

of

of the Authour's Power, He now to gratify the Stationer with ſomething that may in Their ſtead make up the formerly printed Eſſay a Book of a convenient Bulk, has put into his Hands what now comes forth, about ſome Unheeded Cauſes of the Healthfulneſs and Inſalubrity of the Air: *which being chiefly attributed to* Subterraneal Steams, Subtile *and for the moſt part* Inviſible, *are as near of kin to the other* Effluviums *treated of in the Introductory*

ry Diſcourſe, as is requiſite to keep the mention that is made of them in this Book, from appearing very incongruous.

AN

AN *ESSAY* Of the Great EFFECTS Of Even *Languid* and *Unheeded* *LOCAL MOTION.*

CHAP. I.

HOW ſuperficially ſoever the *Local Motion* of Bodies is wont to be treated of by the Schools, who admit of divers other Motions, and aſcribe almoſt all ſtrange things in Phyſicks to *Subſtantial Forms* and *Real Qualities*; yet it will become Us, who endeavour to reſolve the *Phænomena* of Nature into Matter

and Local motion, (*guided*, at the beginning of things, immediately, and ſince *regulated*, according to ſettled Laws, by the Great and Wiſe Author of the Univerſe,) to take a heedfull notice of its kinds and operations, as the true Cauſes of many abſtruſe Effects. And though the induſtry of divers late Mathematicians and Philoſophers have been very laudably and happily exerciſed on the nature and general Laws of this Motion; yet I look upon the Subject in its full extent to be of ſuch importance, and ſo comprehenſive, that it can never be too much cultivated, and that it compriſes ſome parts that are yet ſcarce cultivated at all. And therefore I am not ſorry to find my ſelf obliged, by the deſign of theſe Notes, (written, as you know, to facilitate the explicating of *Occult* Qualities) to endeavour to improve ſome neglected Corners of this vaſt field, and to conſider, Whether, beſides thoſe effects of Local motion which are more conſpicuous, as being produced by the mani-

manifeſt ſtriking of one body againſt another, where the bulk, &c. of the Agent, together with its Celerity, have the chief Intereſt; there may not be divers effects, wont to be attributed to Occult Qualities, that yet are really produced by *faint* or *unheeded* Local motions of bodies againſt one another, and that oftentimes at a diſtance.

But, before I enter upon particulars, this I muſt premiſe in general, (which I have elſewhere had occaſion to note to other purpoſes,) that we are not to look upon the bodies we are converſant with, as ſo many Lumps of Matter, that differ onely in bulk and ſhape, or that act upon one another merely by their own diſtinct and particular powers; but rather as bodies of peculiar and differing internal Textures, as well as external Figures: on the account of which ſtructures, many of them muſt be conſidered as a kind of Engines, that are both ſo framed and ſo placed among other bodies, that ſometimes Agents, otherwiſe in-

valid, may have notable operations upon them, because those operations being furthered by the Mechanism of the body wrought on, and the relation which other bodies and Physifical Causes have to it, a great part of the effect is due, not precisely to the external Agent, that 'tis wont to be ascribed to, but in great measure to the action of one part of the body it self (that is wrought on) upon another, and assisted by the concurring action of the neighbouring bodies, and perhaps of some of the more Catholick Agents of Nature. This Notion or Consideration being in other Papers particularly confirmed, I shall not now insist upon it, trusting that you will not forget it, when there shall be occasion to apply it in the following Notes.

There may be more Accounts than we have yet thought of, upon which *Local motions* may perform considerable things, either without being much heeded, or without seeming other then faint, at least in relation to the

the conſiderableneſs of the Effects produced by them. And therefore I would not be underſtood in an excluſive ſenſe, when in the following Diſcourſe I take notice but of a few of the above-mentioned Accounts; theſe ſeeming ſufficient, whereto, as to Heads, may be conveniently enough referred the Inſtances I allot to this Tract.

And concerning each of theſe Accounts, I hold it requiſite to intimate in this place, that I mention it onely, as that whereon ſuch effects of Local motion, as I refer to it, do principally depend: for, otherwiſe, I am ſo far from denying, that I aſſert, that in divers caſes there are more Cauſes than one, or perhaps than two of thoſe here treated of apart, that may notably concur to *Phænomena* directly referred to but one or other of them.

To come then cloſer to our ſubject; I ſhall take notice, That among the ſeverall things, upon whoſe account men are wont to overlook or under-

value the efficacy of Local motions, that are either Unheeded or thought Languid, the chief, or at leaſt thoſe that ſeem to me fitteſt to be treated of in this Paper, are thoſe that are referable to the following Obſervations.

CHAP. II.

Obſervat. I. *Men are not uſually aware of the great efficacy of* Celerity, *even in ſmall Bodies, and eſpecially if they move but through a ſmall ſpace.*

WHat a rapid Motion may enable a Body to doe, may be judged by the powerfull and deſtructive Effects of Bullets ſhot out of Cannons, in compariſon of the Battering Engines of the Ancients, which, though I know not how many times bigger then the Bullets of whole Cannon, were not able to batter down Walls and Towers like Bullets, whoſe bulk compared with their is inconſiderable. Other examples

of

of a like nature might be without impertinency alledged on this occaſion; but, becauſe the latter part of our Propoſition contains that which I chiefly aim at, I ſhall proceed to Inſtances fit to prove That.

I have ſometimes cauſed a skilfull Turner to turn for me an oblong piece of Iron or Steel, and placing my naked hand at a convenient diſtance to receive the little fragments, perhaps for the moſt part leſſer then ſmall pins heads, as they flew off from the rod, they were, as I expected, ſo intenſely heated by the quick action of the Tool upon them, that they ſeemed almoſt like ſo many ſparks of fire; ſo that I could not endure to continue my hand there. And I remember, that once asking an expert workman, whether he (as I had ſometimes done) did not find a troubleſome heat in the little fragments of Braſs that were thrown off when that metall was turning? He told me, that heat was ſometimes very offenſive to his eyes and eye-lids. And

when I asked, whether it was not rather as Duſt caſt into them, than from their Heat; he replied, that beſides the ſtroke, he could ſenſibly feel a troubleſome heat, which would make even his Eye-lids ſore: And that ſometimes, when he employed a rough Tool, that took off ſomewhat greater Chips, he had found the heat ſo vehement, that not onely 'twould ſcorch his tender Eye-lids, but the thick and hard skin of his hands: for proof whereof he ſhewed me in one of his hands a little bliſter, that had been ſo raiſed, and was not yet quite gone off.

And inquiring about theſe matters of a famous Artiſt, imployed about the finiſhing up of caſt Ordnance, he confeſs'd to me, That, when with a ſtrong as well as peculiar Engine he and his aſſociates turned great Guns very ſwiftly, to bring the ſurface to a competent ſmoothneſs, the tools would ſometimes throw off bits of metal of a conſiderable bigneſs, which, by reaſon of their bulk and their rapid motion, would be ſo heated as to burn

the fingers of the Country-people that came to gaze on his work, when he, for merriment ſake, deſired them to take up ſome of thoſe pieces of metall from the ground. Which I thought the more remarkable, becauſe by the Contact and Coldneſs of the ground I could not but ſuppoſe their Heat to have been much allayed. Not to mention, that I learnt from an experienced Artificer, that in turning of Braſs the little fragments of that metall acquire an intenſer Heat than thoſe of Iron.

I remember alſo, that, to vary the Experiment mentioned juſt before this laſt, by making it with a bodie far leſs ſolid and heavy than Braſs or Iron, I cauſed an Artificer to turn very nimbly a piece of ordinary wood, and holding my hand not far off, the powder, that flew about upon the operation, ſtruck my hand in many places with that briskneſs, that I could but uneaſily endure the Heat which they produced where they hit. Which Heat whether it were com-

mu-

municated from the little, but much heated, fragments to my hands, or produced there by the brisk percuſſion on my hand, or were the joint effect of both thoſe Cauſes; it will however be a good Inſtance of the power of *Celerity* even in very ſmall bodies, and that move but a very little way.

'Tis conſiderable to our preſent purpoſe, that by an almoſt momentany percuſſion, and that made with no great force, the parts, even of a vegetable, may be not onely intenſely heated, but brought to an actuall Ignition; as we have ſeverall times tried, by ſtriking a good Cane (of that ſort which is fit for ſuch Experiments) with a ſteel, or even with the back of a knife. For, upon this Colliſion, it would ſend forth ſparks of fire like a flint.

To the ſame purpoſe may be alledged, that, by but dextrouſly ſcraping good loaf-ſugar with a knife, there will be made ſo brisk an agitation of the parts, that ſtore of ſparks will

will be produced. But that is more conſiderable, which happens upon the colliſion of a flint and a ſteel: For, though Vitrification be by Chymiſts eſteemed the ultimate action of the fire, and though, to turn ſand or ſtones, though very finely poudered, into glaſs, 'tis uſually required that it be kept for divers hours in the intenſe fire of a glaſs-houſe; and though, laſtly, the glaſs-men complain, that they cannot bring flints or ſand to fuſion without the help of a good proportion of *Borillia* or ſome other fixed ſalt: yet both actuall Ignition and Vitrification are brought to paſs almoſt in a moment by the bare vehemence of that motion that is excited in the parts of a flint when it is ſtruck with a ſteel: For thoſe ſparks that then fly out, (as an Ingenious perſon has obſerved, and as I have often ſeen with a good Microſcope,) are uſually real and permanent parcels (for the moſt part globulous) of ſtone vitrified and ignited by the vehemence of the motion. And that *Mr. Hooke.*

this

this vitrification may be of the ſtone itſelf, though ſteel be a metal of a far more fuſible nature then a flint, I am induced to think, becauſe I have tried, that not only flints with ſteel, but flints with flints, and more eaſily pieces of Rock-Cryſtal between themſelves, will by colliſion ſtrike fire. And the like effect of colliſion I have found my ſelf in ſome precious ſtones, harder than Cryſtall. And afterwards inquiring of an ingenious Artificer that cuts Diamonds, Whether he had not obſerved the like, when Diamonds were grated on by the rapid motion of his mill? He replied, that he obſerved Diamonds to ſtrike fire almoſt like Flints; which afterwards was confirmed to me by another experienced cutter of Gems; and yet having made divers trials on Diamonds with fire, he would not allow that fire itſelf can bring them to fuſion.

Nor are fluid Bodies, though but of ſmall Dimenſions, to be altogether excluded from the power of making conſiderable impreſſions on ſolid bodies,

bodies, if their celerity be great.

Whether the Sun-beams conſiſt, according to the Atomical Doctrine, of very minute Corpuſcles, that, continually iſſuing out of the body of the Sun, ſwiftly thruſt on one another in Phyſically-ſtraight Lines; or whether, as the *Carteſians* would have it, thoſe beams be made by the brisk action of the Luminary upon the contiguous fluid, and propagated every way in ſtraight lines through ſome Ethereal matter harboured in the pores of the Air; it will be agreeable to either *Hypotheſis*, that the Sun-beams, refracted or reflected by a burning-glaſs to a *focus*, do there, by their concourſe, compoſe a ſmall portion of fluid matter; and yet the *Celerity*, wherewith the ſoft and yielding ſubſtance is agitated, enables ſo few of them as can be circumſcribed by a Circle, not a quarter of an inch in Diameter, to ſet afire green wood in leſſe than a minute, and (perhaps in as little time as that) to melt not onely Tinn and Lead thinly bea-

beaten, but, as I have tried, foliated Silver and Gold.

The operation of ſmall portions of fluid matter on ſolid bodies will be farther exemplified in the IV. *Chapter*, by the effects of the blown flame of a Lamp on glaſs and metalls; ſo that I ſhall here need but to point in general at the wonderfull effects that *Lightning* has produced, as well by the Celerity of its motion, as by the matter whereof it conſiſts. Of which Effects, Hiſtories and the writings of Meteorologiſts afford good ſtore; and I have been an admiring obſerver of ſome of them, one of the laſt of which was the melting of metal by the flame in its paſſage, which probably laſted but the twinckling of an Eye.

And even a ſmall parcel of Air, if put into a ſufficiently-brisk motion, may communicate a conſiderable motion to a ſolid body; whereof a notable Inſtance (which depends chiefly upon the Celerity of the ſpringy corpuſcles of the Air) is afforded by

by the violent motion communicated to a bullet ſhot out of a good wind-gun. For, when this Inſtrument is well charged, the ſtrongly-compreſt Air being ſet at liberty, and forcibly endeavouring to expand it ſelf to its wonted laxity, its corpuſcles give a multitude of impulſes to the bullet, all the while that it continues moving along the barrel, and by this means put it into ſo rapid a motion, that I found by trial, the bullet would in a moment be flatted, almoſt into the figure of a Hemiſphere, by being ſhot off againſt a metalline plate.

And farther to ſhew, How ſwift that motion muſt have been, and with what Celerity a vehement agitation may be communicated to the parts of a Solid body, I ſhall add here (though the *Phænomenon* might be referred to the V. *Chapter*,) that, though the contact of the Bullet and the metalline plate laſted probably but a phyſical moment; yet the minute parts of the bullet were put into ſo various and briſk an agitation, that making haſt

to

to take it up before it ſhould cool, I found it too hot to be with overmuch eaſe held between my fingers.

CHAP. III.

Obſervat. II. *We are too apt to think, that Fluid bodies, becauſe of their ſoftneſs, cannot have by their bare motion, eſpecially if inſenſible, any ſenſible effect upon Solid ones; though the fluid moves and acts as an intire body.*

'TIS not my purpoſe here to inſiſt on the efficacy of the motion of ſuch fluid bodies as may have their motions diſcovered by the eye, like ſtreaming water; or manifeſtly perceived by the touch, as are the winds that beat upon us: ſince 'twere needleſs to give Inſtances of ſuch obvious things, as the great effects of overflowing waters and violent winds; the later of which, notwithſtanding the great tenuity and ſoft-

ſoftneſs of the air and the *Effluvia* that ſwim in it, have been ſometimes able to blow down not onely timber-trees, but houſes and ſteeples, and other the firmeſt Structures. But the motions I intend to ſpeak of in this Chapter are ſuch, as we do not immediately either ſee or feel; and though theſe be exceeding rare, yet the operation of *Sounds*, even upon ſolid bodies, and that at a diſtance from the ſonorous ones, afford me ſome Inſtances to my preſent purpoſe, which I ſhall now proceed to mention.

It has been frequently obſerved, that, upon the diſcharge of Ordnance and other great Guns, not onely the ſound may be diſtinctly heard a great way off; but that, to a good diſtance, the tremulous motion of the Air that produces ſound, without producing any ſenſible wind, has been able ſenſibly to ſhake, and ſometimes violently to break, the glaſs-windows of houſes and other buildings, eſpecially when the windows ſtand in the way

wherein the propagation of the ſound is directly made. 'Tis true, that theſe obſervations are moſt frequent, when the place, where the Artillery is placed, ſtands upon the ſame piece of ground with the Houſes whoſe windows are ſhaken; and ſo it may be ſuſpected, that the Shake is firſt communicated by the Cannon to the earth or floor on which they play, and is afterwards by that propagated through the intermediate parts of the ground to the foundations of the houſes, and ſo to the windows. And I readily grant, and may elſewhere ſhew, that a violent impulſe upon the ground may reach to a greater diſtance than men uſually imagine: But in our preſent Caſe I ſee no neceſſity of having recourſe to any thing but the wave-like motion of the Air for the production of our Phænomenon ſince the like may be produced by Local Motion tranſmitted by Fluids as may appear by the following Inſtances.

I was once invited by an Enginee

to ſee triall made of a ſtrange Inſtrument he had to ſink ſhips, though great ones, in a few minutes; and though an unlucky Accident kept me from arriving there 'till near a quarter of an hour after the triall had been made on an old fregat, with better ſucceſſe than my Philanthropy allowed me to wiſh; yet cauſing my ſelf to be rowed to the place, where the great veſſell was newly ſunk, the odneſs of the effect, which was performed upon the water by a ſmall Inſtrument outwardly applied, made me inquiſitive, what noiſe and commotion had been made: And I was informed partly by the Engineer himſelf, and partly by ſome acquaintances of mine, who among a great number of Spectators ſtood aloof off in ſhips and other veſſels lying at anchor, to ſee the event; that, upon the Engine's operating, the exploſion was ſo great, that it made a kind of ſtorm in the water round about, and did ſo rudely ſhake veſſels that lay at no inconſiderable diſtance, as to make

thoſe that ſtood on them to ſtagger.

In the late great Sea-fight between the Engliſh Fleet commanded by his Royal Highneſs the Duke of *York*, and the Dutch Admiral *Opdam*, (who therein loſt the Victory and his Life,) though the Engagement were made very many Leagues from the *Hague*, yet the noiſe of the Guns not onely reached to that Place, but had a notable effect there; of which when I enquired of the Engliſh Embaſſadour that as yet reſided there, he was pleaſed to aſſure me, that it ſhook the windows of his Houſe ſo violently, that not knowing what the Cauſe was, he was ſurprized and much allarmed, apprehending, that ſome rude Fellows were about to break his windows to affront him. And if there be a greater diſpoſition in ſome other bodies than there is in Glaſs-windows to receive ſtrong impulſes from the Air agitated by Sounds, theſe may be ſenſibly, though not viſibly wrought upon, and that at a good diſtance, by the noiſe of a ſingle piec

piece of Ordnance; as may appear by that memorable Circumſtance of an odd Caſe about a Gangrene mentioned by the experienced *Simon Pauli* in his ingenious Tract *de Febribus malignis*, pag. 71. *Atqui æger ille Gallus brachio truncatus, octiduum quidem ſuperfuit, ſed horrendis totius corporis convulſionibus correptus; qui quoque, (ut & illa addam obſervatione digniſſima,) dum in Domini ſui ædibus ad plateam Kiodmoggerianam, Romanè* Laniorum *appellares, decumberet, ac, me ac aliis aliquandiu ad Lectum illius conſidentibus quidem, ſed nobis non attendentibus, exploderentur tormenta bellica ex Regiis ac Prætoriis navibus, ſiniſtrâ truncum dextri brachii fovens ac complectens, toties quoties exploderentur ſingula exclamabat, Au, au, me miſerum! Jeſu, Maria, contundor penitùs: adeò permoleſta & intolerabilis illi erat Tormentorum exploſio, & quidem ex loco ſatis longinquo, terrâ non firmâ aut contiguâ, verùm ſuper ſalo aut mari Balthico, inſtituta.* By this it appears, that the Guns, whoſe diſcharge pro-

duced these painfull motions in the Patient, rested upon a floating body. And I remember, that an illustrious Commander of a very great Man of war, being asked by me, whether of the many wounded men, he had in his ship in a very long Sea-fight, none of them were affected by that noise of the Enemy's Cannon discharged in ships at a distance? He answered me, that some, whose bones were broken, would sadly complain of the Torment they were put into by the shake they felt at the going off of the Enemy's Cannon, though they were too much accustomed to the report of great Guns, to be, as 'twas a bare noise, offended by it. If after all this ti be surmized, that these motions were not conveyed by the air, but propagated by the water, (and, in some cases, some part of the shoar) from the ships, where the Guns were fired, to the Houses where the windows were shaken, or the place where the wounded men lay: I answer, that, if this could be made probable

bable, it would accommodate me with very eminent Inſtances for the Chapter of the *Propagable* nature of Motion: And though it be very difficult to find ſuch examples of ſhakes excited by ſounds as are not liable to the mentioned objection; becauſe the ſonorous bodies here below do all either ſtrike, or lean, upon ſuch groſs and viſible bodies as the Earth and Water; yet there is one kind of Sound, that muſt be confeſſed to be propagated by the Air, as being made in it; and that is *Thunder*, whoſe noiſe does ſometimes ſo vehemently affect the Air, though without producing any ſenſible wind, that both others and I have obſerved it very ſenſibly to ſhake great and ſtrong Houſes, notwithſtanding the diſtance of the clouds where the noiſes were firſt produced. And I remember, that, having inquired of ſome Sea-Captains, that in ſtout veſſels ſailed to the *Indies*, whether they had nor in thoſe hot Regions obſerved their ſhips, though very much leſs tall then

houſes, to be ſhaken by vehement Thunders? I perceived, that ſome of them had not much heeded any ſuch thing; but a couple of others told me, they had obſerved it in their ſhips; and one of them told me, that once, when the claps of thunder were extraordinary great, ſome of them ſhook his ſhip ſo rudely as to make the unwonted motions diſorder his great Guns. All which I the leſs wonder at, when calling to mind, what I have mention'd in the foregoing Chapter and elſewhere of the power of the Celerity of motion, I conſider, that there is no Celerity that we know of here below, that is near ſo great, as that wherewith a Sound is propagated through the air. For, whereas the diligent *Merſennus* obſerves, that a bullet ſhot out of a Cannon or a Muſket does not overpaſs two hundred and forty yards in a Second, or ſixtieth part of a minute; I have more than once diligently obſerved, that the motion of *Sound* paſſes above four hundred yards in the

ſame

ſame time of a Second here in *England*; which I therefore add, becauſe *Merſennus* relates, that in *France* he obſerved a Sound to move in that time many yards more; which may poſſibly proceed from the differing conſiſtence of the Engliſh air and the French.

The great Loudneſs of theſe ſounds, and the vehement percuſſion that the Air receives in their formation, will probably make it be eaſily granted, that 'twas onely the Impetuoſity of the motion of the *Medium*, that gave the ſhake to the windows and other ſolid bodies that I have been mentioning to have been made to tremble by the report of Cannon or Thunder: But yet I will not on this occaſion conceal, that perhaps it may without abſurdity be ſuſpected, that Some of thoſe tremulous motions of ſolid bodies might either depend upon, or at leaſt be promoted by, ſome peculiar diſpoſition, that Glaſſe (which is endued with ſpringineſs,) and ſome other bodies that perhaps are not quite devoid of that Quality,

may

may have to be moved by certain congruous Sounds (if I may ſo call them) more than they would by others, though perchance more loud. But though this ſurmize ſhould be admitted; yet it would not render the lately-recited Inſtances improper for the deſign of this Diſcourſe, but onely would make ſome of them fit to be referred to another *Chapter*; to which I ſhall advance, as ſoon as I ſhall have annexed an odd Obſervation of the experienced *Platerus*, which argues, that, where there is a peculiar Diſpoſition, even in a firm body, it may receive conſiderable impreſſions from ſo languid a motion (though in likelihood not peculiarly modified) of the air as is not ſenſible to other bodies of the ſame kind.

Plater. Obſerv. Lib. 1. p. 185. *Fœmina quædam* (ſays he) *in ſubitaneum incidit morbum, viribus ſubitò proſtratis, ſe ſuffocari indeſinenter clamitans, etſi nec ſtertoris nec tuſſis aliqua eſſent indicia; maximè verò de aura quadam adveniente, ſi vel leviter aliquis adſtantium ſe moveret,*

moveret, quæ illam opprimeret, conquerebatur, ſéque ſuffocari, ſi quis propiùs accederet, clamitabat: vixdum biduum in ea anxietate perſeverans, expiravit. To which he adds: *Vidi & alios ægros, de ſimili aura, quæ eos, ſi quis illis appropinquaret, in ſuffocationis periculum induceret, conquerentes; quod ſemper peſſimum eſſe ſignum deprehendi.*

CHAP. IV.

Obſervat. III. *Men undervalue the motions of bodies too ſmall to be viſible or ſenſible, notwithſtanding their* Numerouſneſs, *which enables them to act in Swarms.*

MOſt men, when they think at all of the *effluvia* of bodies and their motions, are wont to think of them as if they were but much finer ſorts of Duſt, (whoſe grains, by reaſon of their ſmalneſs, are inviſible,) which, by the various agitation of the Air, are

as

as 'twere by ſome faint wind blown againſt the ſurfaces of the bodies they chance to meet in their way, and that they are ſtopped in their progreſs without penetrating into the interior parts of the bodies they invade. And according to this Notion, 'tis no wonder, that men ſhould not fancy, that ſuch minute bodies paſſing, as they ſuppoſe, no further than the ſurfaces of thoſe on which they operate, ſhould have but faint operations upon them.

But we may have other thoughts, if we well conſider, that the Corpuſcles we ſpeak of, are, by their minuteneſs, aſſiſted, and oftentimes by their figure inabled, to pierce into the innermoſt receſſes of the body they invade, and diſtribute themſelves to all, or at leaſt to multitudes of the minute parts, whereof that body conſiſts. For this being granted, though we ſuppoſe each ſingle *effluvium* or particle to be very minute; yet, ſince we may ſuppoſe, even ſolid bodies to be made up of particles that are ſo too, and the number of invading particles

to

to be not much inferior to that of the invaded ones, or at leaſt to be exceedingly great, it need not ſeem incredible, that a multitude of little Corpuſcles in motion (whoſe motion, may, for ought we know, be very ſwift) ſhould be able to have a conſiderable operation upon particles either quieſcent, or that have a motion too ſlow to be perceptible by ſenſe. Which may perhaps be the better conceived by the help of this groſs example:

If you turn an Ant-hill well ſtocked with Ants-eggs, upſide down, you may ſometimes ſee ſuch a heap of eggs mingled with the looſe earth, as a few of thoſe Inſects, if they were yoaked together, would not be able at once to draw after them; but if good numbers of them diſperſe themſelves and range up and down, and each lay hold of her own egge, and hurry it away, 'tis ſomewhat ſurprizing to ſee (as I have with pleaſure done) how quickly the heap of eggs will be diſplaced, when almoſt every little egge has one

one of thoſe little Inſects to deal with it.

And in thoſe caſes, wherein the invading Fluid does not quite disjoin and carry off any great number of the parts of the body it invades, its operation may be illuſtrated by that of the wind upon a tree in *Autumn*: for, it finds or makes it ſelf multitudes of paſſages, for the moſt part crooked, not onely between the branches and twigs, but the leaves and fruits, and in its paſſing from the one ſide to the other of the tree, it does not onely variouſly bend the more flexible boughs and twigs, and perhaps make them grate upon one another, but it breaks off ſome of the ſtalks of the fruit, and makes them fall to the ground, and withall carries off divers of the leaves, that grew the leaſt firmly on, and in its paſſage does by its differing parts act upon a multitude of leaves all at once, and variouſly alters their ſituation.

But to come to cloſer Inſtances:

ſup-

ſuppoſe we caſt two lumps, the one of Sugar, the other of Amber, into a glaſs of beer or water, they will both fall preſently to the bottom. And though perhaps the Amber may be lighter than the Sugar, (for, I have found a notable difference in the ſpecific gravity of pieces of Amber,) yet the aqueous particles are far from being able to diſplace the Amber or any ſenſible part of it, or exerciſe any viſible operation upon it: But the ſame minute particles of the liquor being of a figure that fits them to inſinuate themſelves every way into the pores of the Sugar, though the lump conſiſted of very numerous Saccharine Corpuſcles, yet the multitude of the aqueous particles, to which they are acceſſible, is able in no long time to diſperſe them all, and carrying them along with themſelves, make the whole lump of Sugar in a ſhort time quite diſappear.

The point above diſcourſed of, may be more nimbly exemplified in ſome Chymical operations, and particu-

ticularly in this. If, by a due degree of fire, you abſtract from running Mercury four or five times its weight of good Oil of Vitriol, there will remain at the bottom a dry and brittle ſubſtance exceeding white; and, if upon this Heap of Mercurial and Saline bodies, which ſometimes may be coherent enough, you pour a good quantity of limpid water, and ſhake them together, you may ſee in a trice the multitude of little white grains, that make up the maſſe, pervaded, and manifeſtly altered, by the diſperſed Corpuſcles of the water; as will plainly appear by the change of the *Calx* or *Precipitate* from a white maſſe into one of a fine Limon-colour.

But to give inſtances in Fluid bodies, (which I ſuppoſe you will think far the more difficult part of my task,) though you will eaſily grant that the flame of Spirit of wine, that will burn all away, is but a viſible aggregate of ſuch *Effluvia* ſwiftly agitated, as without any ſenſible Heat would

would of themſelves inviſibly exhale away; yet, if you be pleaſed to hold the blade of a knife, or a thin plate of Copper, but for a very few minutes, in the flame of pure Spirit of wine, you will quickly be able to diſcern by the great Heat, that is, the various and vehement agitation of the minute Corpuſcles of the metal, what a number of them muſt have been fiercely agitated by the pervaſion of the igneous particles, if we ſuppoſe, (what is highly probable,) that they did materially penetrate into the innermoſt parts of the metall; and whether we ſuppoſe this or no, it will, by our experiment, appear, that ſo fluid and yielding a body, as the flame of Spirit of wine, is able, almoſt in a trice, to act very powerfully upon the hardeſt metalls.

The power of extreamly-minute parts of a fluid body, even when but in a moderate number they are determined to conſpire to the ſame operation, may be eſtimated by the

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The power of extreamly-minute parts of a fluid body, even when but in a moderate number they are determined to conſpire to the ſame operation, may be eſtimated by the

motions of Animals, especially of the larger and more bulky sorts, as Horses, Bulls, Rhinocerots and Elephants. For, though the animal spirits be minute enough to be invisible, and to flow through such tender passages, that prying Anatomists have not been able in dissected Nerves to discern so much as the channels through which they pass yet those Invisible Spirits, conveyed (or impelled) from the Brain to the Nerves, serve to move in various manners the Lims, and even the unwieldy bodies themselves of the greatest Animals, and to carry them on in a progressive motion for many hours together, and perhaps enable them to spring into the Air, and move through it by leaping; though divers of these Animals weigh many hundred, and others several thousand of pounds.

I will not here consider, whether the following Experiment may at illustrate Motions that are produced by the fluid parts of Animals in so

of the consistent ones: But I presume, it may confirm the Observation maintained in this Chapter, if I add, what I have tried of the considerable force of a number of aqueous particles, as flexible and as languid as they are thought to be, insinuating themselves into the pores or Intervals of a rope that was not thick. For in moist weather I sometimes observed, that the aqueous and other humid particles, swimming in the air, entering the pores of the hemp in great numbers, were able to make it shrink, though a weight of fifty, sixty, or even more pounds of lead were tied at the end to hinder its contraction, as appeared by the weights visibly being raised in wet weather above the place it rested at in dry.

But to return to what I was formerly speaking of the Determination of the motion of Fluids; I shall, on this occasion, observe, that, though the wind or breath, that is blown out at a small crooked pipe of metal or glass, such as Tradesmen for its

uſe call a Blow-pipe, ſeems not to have any great celerity, eſpecially in compariſon of that of the parts of flame; and is it ſelf of little force: yet, when by this wind the flame of a Lamp or Candle is directed ſo as to beat with its point upon a body held at a convenient diſtance from the ſide of the flame, the burning fluid determined, and perhaps excited by this wind, acquires ſo great a force that, as we have often tried, it may be made, in a few minutes, to melt not onely the more fuſible Metals, but ſilver, or even copper it ſelf; which yet may be kept for many hours unmelted in a Crucible kept red-hot or even in the flame of the Lamp or Candle, unaſſiſted by the blaſt.

And if we can ſo contrive it, that the flame does not come to invade one of the ſurface that inveſts a body, but comes to be intermingled with the ſmaller (though not the ſmalleſt) parts it conſiſts of, as with its filings or its powder; the flame will then have a far more quick and powerful

op-

operation than the body expoſed to it. This I exemplify (in other Papers) and in this place it may ſuffice to obſerve, that, whereas a pound or two of Tartar may coſt you ſome hours to calcine it to whiteneſs, if the flame have immediate acceſs onely to the outward parts; you may calcine it in a very ſmall part of that time, if, mixing with its groſs powder an equal weight of good Salt-peter, you fire the mixture, and keep it ſtirring, that the parts of the kindled Nitre may have acceſs at once to very many parts of the Tartar, and have opportunity to calcine them. And by ſomewhat a like artifice, I elſewhere teach, how Nitre it ſelf may without Tartar be ſpeedily reduced to a *Calcinatum*, not unlike that newly mentioned. But it may be ſaid, that ſome of the foregoing Inſtances (for it cannot be truly ſaid of all) may indeed illuſtrate what we are diſcourſing of, but will not reach home to our purpoſe.

I ſhall therefore conſider the

Load-ſtone, which you acknowledge to act by the emiſſion of Inſenſible particles. For, though Iron and Steel be ſolid and ponderous bodies, and Magnetical *effluvia* be corpuſcles ſo very minute, that they readily get in at the pores of all kind of bodies, and even of Glaſs it ſelf; yet theſe Magnetical *effluvia*, entring the ſteel in ſwarms, do in a trice pervade it and a multitude even of Them, acting upon the Corpuſcles of the metal, do operate ſo violently on them, that, if the *Load-ſtone* be vigorous enough and well capped, it will attract a no table proportion of ſteel, and ſur mount the gravity of that ſolid meta which I have found to exceed, whe the ſtone has been very good and li tle, above fifty times the weight o the Magnet by whoſe *effluvia* it wa ſupported: For, to theſe I rather a ſcribe Magnetical attraction and ſu tentation, than to the impulſe o preſſure of the ambient air, to whi many Corpuſcularians have recourſe becauſe I have found by trial (whi

I elſe

I elſewhere relate) that the preſſure of the ambient air is not abſolutely neceſſary to Magnetical operations.

I remember, that, to help ſome friends to conceive, how ſuch extreamly-minute particles as Magnetical *effluvia*, may, by pervading a hard and ſolid body, ſuch as Iron, put its inſenſible Corpuſcles into motion, and thereby range them in a new manner, I took filings of Steel or Iron freſhly made, that the Magnetical virtue might not be diminiſhed by any ruſt, and having laid them in a little heap upon a piece of paper held level, I applied to the lower ſide of the paper, juſt beneath the Heap, the pole of a vigorous Load-ſtone, whoſe Emiſſions traverſing the paper, and diffuſing themſelves through the incumbent metall, did in a trice manifeſtly alter the appearance of the Heap; and, though each of the filings might probably contain a multitude of ſuch ſmall Martiall Corpuſcles as Steel may be divided into by Oil of Vitriol or Spirit of Salt; yet the Mag-

netical *effluvia*, immediately pervading our metalline heap, did ſo remove a good part of the filings that compoſed it, as to produce many erected aggregates, each of which conſiſted of ſeveral filings placed one above another, and appearing like little needles, or rather like the ends of needles broken off at ſome diſtance from the point. And as theſe little temporary needles ſtood all of them erected (though more or leſs, according to their diſtance from the Pole of the Magnet) upon the flat paper; ſo they would, without loſing their figure or connexion, be made as it were to run to and fro upon the paper, according as the Load-ſtone, that was held underneath it, was moved this way and that way; and as ſoon as that was taken quite away, all the little ſtand of pikes (if I may ſo call it) would (almoſt in the twinkling of an eye) relapſe into a confuſed heap of filings.

There are two ways of explicating the turning of Water into Ice; one

or other of which is approved almoſt by all the Corpuſcularian Philoſophers. The firſt is that of the *Carteſians*, who give an account of Glaciation by the receſſe of the leſs ſubtile particles of the Etherial matter, without which the finer parts were too ſmall and feeble to keep the Eel-like particles of water flexible, and in the form of a liquour. The *Atomiſts* on the other ſide aſcribe the freezing of water to the ingreſs of multitudes of *frigorifick* Corpuſcles, as they call them, which, entering the water in ſwarms, and diſperſing themſelves through it, crowd into the pores, and hinder the wonted motion of its parts, wedging themſelves (if I may ſo ſpeak) together with them into a compact body. But which ſoever of theſe two *Hypotheſes* be pitched upon, the Phænomenon it ſelf will afford me a notable Inſtance to my preſent purpoſe. For, the Particles of water, and much more the Corpuſcles of cold, are confeſſed to be ſingly too ſmall to be viſible,

visible, and their motions are not said to be swift, but may rather be judged to be slow enough; and yet those minute aqueous, or more minute frigorifick particles, because of their number, produce in the glaciation of the liquour so forcible a motion outwards, as to make it break bottles, not onely of glass and earth strongly baked, but, as I have several times tried, of metal it self, that being full of the liquour were firmly stopped before the supervening of the Cold. And the expansive endeavour of freezing water is not onely capable of doing this, but of performing so much greater things, which I elsewhere relate, that my trials have made me sometimes doubt, whether we know any thing in nature, except kindled Gunpowder, that bulk for bulk moves more forcibly, though the motion seems to be very slow.

CHAP.

CHAP. V.

(Of the Propagable Nature of Motion.)

Obſervat. IV. *Men are not ſufficiently aware, how propagable Local Motion is, even through differing Mediums, and Solid bodies.*

THere are four principal Occaſions on which I have obſerved, that men are wont to think the Communicating of Motion much more difficult than indeed it is.

And *firſt*, there are many, that obſerving how uſually thoſe bodies that hit againſt hard ones rebound from them, eaſily perſwade themſelves, that Motion can ſcarce be tranſmitted or diffuſed through Solid bodies. But though it be true, that oftentimes in ſuch caſes the progreſſive motion of the body or the Solid,

Solid, that is ſtruck or impelled, be either inconſiderable, or, perhaps, not ſo much as ſenſible; yet the impulſe may make a conſiderable impreſſion, and may be communicated to a great ſhare of the particles of that matter, whereof the ſolid maſs conſiſts; as we ſee in the ſtriking of a timber-beam at one end, the motion, though perhaps it were not ſtrong at the firſt, may become ſenſible at the other. Though Bell-metal be ſo hard a body, that it is reckoned harder than iron it-ſelf, inſomuch that oftentimes it reſiſts even files of Steel, which readily work on Iron; yet this ſolidity hinders not but that, as I have found, conveniently ſhaped veſſels of Bell-metal, though thick, will be ſenſibly affected by a motion that neither is ſtrong, nor touches them in more than a ſhort line, or perhaps than a Phyſical point. The truth of this I have found by trial on more than one ſuch veſſels and particularly on one that was hemiſphærical, which being placed or held in a convenient poſture,

poſture, if I did but gently paſs the point of a pin for a little way along the brim of it, it would ſenſibly reſound, and that (to a very attentive ear) ſo long, and in ſuch a ringing manner, as made it highly probable, that the parts, immediately touched (and not ſo much as ſcratched) by the point of a pin, were not onely put into a vibrating motion themſelves, but were enabled to communicate it to thoſe that were next them, and they to thoſe that were contiguous to them; and ſo the tremulous motion was propagated quite round the bell, and made divers ſucceſſive Circulations before it quite ceaſed to be audible. And if, in ſtead of drawing a Line on the brim of the veſſel, I ſtruck it, though but faintly, with the point of a pin, though the part immediately touched would be but a phyſical point, yet the motion would be, like the former, propagated ſeveral times quite round; as was argued by the ringing and duration of the produced ſound, though this metal-

metalline veſſel were ſeven inches in Diameter, and of a conſiderable thickneſs. Nor was a ſolidity like that of Braſs requiſite to produce theſe effects. For I found them to inſue much after the ſame manner, when I employed onely a ſhort and ſlender thread of Glaſs, which though little, if at all, thicker than a pin, was yet hollow quite through. Now if it be true, as 'tis highly probable that Sound, as it belongs to the air conſiſts in an undulating motion of the Air, and ſo in our caſe requires a vibrating motion in the ſonorous body to impart that motion to the Air; we muſt grant in our Inſtance a wonderfull propagableneſs of motion, even when 'tis not violent, in Solid bodies themſelves; ſince the point of a pin, gently ſtriking a part no bigger than it ſelf, of a maſs of very ſolid metal, could thereby communicate a ſenſible motion, and that ſeveral times circulated, to millions of parts equall to it in bulk, and much exceeding it in hardneſs. And ſince

the effect was more conſiderable, when the trial was made in a much greater, than in a ſmaller veſſel; 'tis probable, that, if I had had the opportunity of experimenting on a large and well-hung Bell, the *Phænomenon* would have been more notable; as it alſo ſeemed to be on our veſſel, if, in ſtead of ſtriking it with the point of a pin, we caſt, though but faintly, againſt the lower part of it a grain of ſhot, leſs than a ſmall pins-head, or let a little grain fall, from about one foot high, upon the inſide of the inverted Hemiſphere. And to ſhew, that even ſoft and yielding bodies, and but faintly moved, are not to be excluded from a power of putting ſuch hard ones into motion; I ſhall add, that I found almoſt the like effects to thoſe above mentioned, by paſſing the pulp of my finger a little way along the lower part of the veſſel. Nay, that fluid bodies themſelves may communicate ſuch an inteſtine and propagable motion, to harden ſolid ones, I may have hereafter

after an occaſion to ſhew by the effects of a ſmall Flame, and the Sun-beams on glaſs and ſteel. And I ſhall here on this occaſion add this word about the Propagation of Motion produced in ſolid bodies by heat, that it much depends upon the particular Textures of the bodies. For I found, that when I heated a piece of glaſs or of a fire-ſtone, I could without inconvenience hold my naked hand upon parts that were very near (ſuppoſe within an inch off) the ignited portions of them. But, if we take a rod of Iron, for inſtance, and heat one end red-hot, the heat of that end will be ſo propagated toward the other, that it will offend one's hand at ſeveral times the diſtance at which one might conveniently hold the rod, if it were of glaſs.

In many buildings it may be obſerved, (and is thought a ſign of the firm Coheſion of their parts,) that a ſtamp of one's foot, nay or bare treading, or ſome ſuch other leſſer brisk impulſe, made in one room, will

will have a ſenſible effect in all or moſt of the others. And it often happens, that, by the haſty ſhutting of a door, the whole houſe is made to tremble; whence we may argue, that, even among ſolid bodies, motion made in one place may be readily propagated to many others: And if, as to the latter of the Inſtances, the ſudden impulſe and compreſſion of the Air, made by the door ſuppoſed to be haſtily ſhut, have any conſiderable ſhare in the effect, the Phænomenon will ſerve to ſhew the efficacy even of ſuch a motion of a fluid body, as we cannot directly feel upon divers large and firmly connected ſolid bodies.

In *Earthquakes* the tremulous motion ſometimes extends ſo very far, that, though it ſeems highly probable, that the ſhake that is given to one part of the Earth by the firing and exploſion of ſubterraneal exhalations, (if that be the true and onely cauſe of Earthquakes) is not capable of reaching near ſo far as divers

Earthquakes have done, but that the fire paſſes through ſome little ſubterraneal clefts, or channels, or hidden conveyances, from one great Cavity or Mine to another; yet 'tis not improbable but that the vehemently tremulous motion does oftentimes reach a very great way beyond the places where the exploſions were made. Since, though *Seneca* would confine the extent of Earthquakes to two hundred miles, yet obſervations made in this and the laſt Century warrant us to allow them a far greater ſpread. The Learned *Joſephus Acoſta* affirms that in the Kingdom of *Peru* in the year 1586 an Earthquake reached along the ſhoar of the Paciſick ſea 160 Leagues; and adds, that ſometimes it has in thoſe parts run from South to North 300 Leagues. And in the beginning of this our age (*Anno Dom.* 1601) good writers relate a much larger Earthquake to have happened, ſince it reached from

Natur. Quæſt. Lib. VI. Cap. 25.

Lib. III. Cap. 26.

Asia to that Sea that washes the *French* Shoars, and, besides some *Asiatick* Regions, shook *Hungary*, *Germany*, *Italy* and *France*, and consequently a great part of *Europe*. And if that part of the Narrative be certain, which relates, that this lasted not much above a quarter of an hour, it will be the more likely, that this Earthquake shook great Tracts of Land beyond those places, to which the fired matter, passing from one cavity to another, could reach in so short a time: As you will the more easily guesse, if you try, as I have done, that in trains of Gunpowder it self the fire does not run on near so swiftly as one would imagine. But though I have been in more Earthquakes then one; yet, since they were too sudden and too short to afford me any considerable observation, I shall say no more of them; but proceed to take notice, that oftentimes the motion of a Coach or Cart, that passed at a good distance from the place that I was in, has made the

buildings ſo ſenſibly ſhake, that I could not but wonder, that ſo great a portion of ſo firm and ſluggiſh a body, as the Earth, could, by a cauſe that ſeemed very diſproportionate to ſuch an effect, be made to tremble it ſelf, and manifeſtly to ſhake firm buildings that were founded on it. And this obſervation made me the more inclinable to give credit to their Relations, who tell us, that in a calm night, the march of a troup of horſe may be felt, by attentive Scouts watching at a great diſtance off, by the ſhake that the ground receives from the trampling of the horſes though I formerly ſuſpected much and do yet a little, that the impulſe of the air conveyed along the reſiſting ſurface of the ground, might main contribute to the effect that is aſcri bed onely to the motion of the ſoil.

Before I advance to the *Secon* Member of this Chapter, it may n be impertinent to note, that in pecul arly diſpoſed bodies, and eſpecial in Organical ones, a very *langu* mo

motion may have a far greater effect, than it could produce by a bare propagation of it ſelf. For it may ſo determine the motion of the Spirits or other active parts of the body it works on, as to make multitudes of them act as if they conſpired to perform the ſame motions. As when a tickliſh man, by having the pulp of one's finger paſſed gently along the ſole of his foot or the palm of his hand, has divers muſcles and other parts of his body and face put into preternatural or unuſual motions. And moſt men by being lightly tickled with the end of a feather or ſtraw, within their Noſtrils, have their heads and many parts of their bodies put into that violent Commotion, wherein *Sneezing* conſiſts. And I remember, that having for ſome time been, by a diſtemper, (from which God was graciouſly pleaſed a while after to free me,) quite deprived of the uſe of my hands; it more than once hapned to me, that ſitting alone in a Coach, if the wind chanced to

blow a ſingle hair upon my face in the Summer-time, the tickling or itching, that it produced, was ſo uneaſy to me, 'till by calling out to a footman I could get it removed, that, though I could well bear it as long as I was wont to do, when, having the uſe of my hands, I could relieve my ſelf at pleaſure; yet if I were forced to endure the itching too long, before any came to ſuccour me, the uneaſineſs was ſo great, as to make me apprehend falling preſently either into Convulſions or a Swoon. But 'tis time to proceed to the *ſecond* Member of this Chapter.

2. Others there are, that cannot believe, that Local motion, eſpecially if it be *languid*, can be propagated through differing Mediums, each of which, ſave that wherein the Motion is begun, muſt, they think, either repell, or check and dead it. To theſe I ſhall recommend the Conſideration of an Experiment, I remember I made before ſome Learned men in our Pneumatick Engine. For, having

caused a large and thick glass Receiver to be so blown, that it had a glass button in the inside of that part which upon the Engine was to be placed upwards; I caused a Watch to be suspended by a little Silver-chain fastned to that button by as slender and soft a body, as I thought would be strong enough to support my watch; and then, the Glass being cemented on close to the Receiver, to prevent a Commerce between the Cavity of it and the Air, the watch, that hung freely near the middle of the Cavity of the Receiver, made it self to be heard by those attentive Listners, that would hold their ears directly over the suspended watch, whose motions were thereby argued to have been propagated, either through the included air, or along the string to the concave part of the Glass, and through the whole thickness of the Glass to the convex part, and thence, through the interposed air to the Ear. And this mention of watches minds me of what I often ob-

ſerved in a ſmall ſtriking watch, that I have worn in my pocket. For, when it ſtruck the Hours, and in ſome poſtures when the balance did but move, I could plainly feel the brisker motions of the Bell, and ſenſibly the languid ones of the balance, through the ſeveral linings of my Breeches, and ſome other interpoſed ſoft and yielding bodies; and this, though the watch (as I ſaid) was ſmall, and the balance included in a double caſe, and though the outwardmoſt were of (what they call) Chagrine, and the innermoſt of Gold; which I therefore mention, becauſe that cloſeſt of metals is obſerved more to deaden ſounds and motions than harder metals, as Silver, Copper, and Iron.

That Motion may be propagated through differing Mediums, may ſeem the more probable by the ſhakings that are often felt by men lying on beds that ſtand in rooms cloſe ſhut when loud claps of thunder are produced (perhaps at a great diſtance off) in the clouds. And whether it will

will be fit to add to this Inſtance that which you have lately met with in the III. Chapter of a wounded Frenchman at *Copenhagen*, I leave you to conſider.

I know not whether it will be very proper to take notice on this occaſion of an odd *Phænomenon* recited by the experienced *Agricola* in theſe words. *Si animal dejicitur in antrum Viburgenſe, quod eſt in Carelia, Regione Scandiæ, erumpit, ut perhibent, ſonus intolerabilis magno cum flatu: Si leve pondus in ſpecum Dalmatiæ, quamvis, inquit Plinius, tranquillo die, turbini ſimilis emicat procella.* *De nat. eorum quæ effl. è Terra Lib. IV. Cap. 7.*

3. As thoſe of whom I took notice at the beginning of this Chapter, are backward to allow, that Motion may be conſiderably propagated through *ſolid* bodies; ſo on the contrary, there are others that are indiſpoſed to think, that 'tis near ſo propagable as indeed it is through *fluid* bodies; becauſe they preſume, that the eaſy ceſſion of the parts of fluids will

will dead the impulse received by those of them that are first acted on by the impelling body. And

4. There is yet another sort of Naturalists, who, though they may be brought to grant, that Motion may by propagated even through a soft and yielding Medium, cannot believe, that it should through such a Medium be propagated to any considerable distance; being perhaps induced to this opinion by observing, that, though a body somewhat broad as well as solid, as the Palm of one's hand or a battledore, be moved through the Air swiftly enough to make a wind; yet that wind will not be strong enough to be felt any more than a very little way off. Wherefore, because the Instances, to which I assign the remaining part of this Chapter, may be for the most part applicable to the removal of both these prejudices; It may for brevity sake be expedient to consider them both together.

If Luminous bodies act on our

Eyes,

Eyes, not by a ſubſtantial diffuſion of extreamly minute particles, as the *Atomiſts* would have it, but by a propagated Pulſion of ſome Subtile matter contiguous to the ſhining body, (as the *Carteſians* and many other Philoſophers maintain;) 'twill be manifeſt, that a body leſs than a ſmall pin's head may give a brisk motion to a portion of fluid matter many millions of times greater than it ſelf; ſince in a dark night a ſingle ſpark of fire may be ſeen in differing places, whoſe diſtance from it exceeds many thouſand times the ſpark's *Diameter*. Not to mention the great remove, at which the flame of a ſmall taper may not onely be ſeen, but appear greater than near at hand. And if we compare the *Diameter* of that bright Planet *Venus*, which yet ſhines but with a borrowed and reflected Light, with its *diſtance* from the Earth, we may eaſily conclude, that the fixed Stars, which probably are ſo many Suns that ſhine by their own native Light, muſt impell a ſtupendi-

pendious proportion of Etherial matter, to be able at that immenſe diſtance to make ſuch vivid Impreſſions, as they do, upon our Eyes. But to deſcend to Inſtances leſs remote and diſputable, I ſhall, in order to the removal of the two lately mentioned prejudices, proceed to conſider; that, though it be true, that Fluid bodies do eaſily yield to Solid ones that impell them, and thereby oftentimes quickly dead the motion of thoſe Solids; yet the motion, being loſt onely in regard of the ſolid body, is not loſt, but tranſmitted and diffuſed in reference to the fluid. As when a log of wood, or any ſuch body ſpecifically lighter than water is let fall in the middle of a pond though its progreſs downwards be checkt, and it be brought to reſt quietly on the ſurface of the water; yet its motion is not loſt, but communicated to the parts of the water it firſt ſtrikes againſt, and by thoſe to others 'till at length the curls or waves produced on the ſurface of the wa-
ter

ter ſpread themſelves, till they arrive at the brinks, and would perhaps be farther expanded, if theſe did not hinder their progreſs. From which inſtance we may learn, that, though the nature of fluid bodies, as ſuch, requires, that their parts be actually diſtinct and ſeparately moved; yet the particular Corpuſcles that compoſe them, being (at leaſt here below) touched by divers others, the new motion that is produced in ſome of them by an impellent Solid, muſt needs make them impell the contiguous Corpuſcles, and theſe thoſe that chance to lie next to them, and ſo the impulſe may be propagated to a diſtance; which you will the more eaſily believe may be great, if you conſider with me, both that in a fluid body the Corpuſcles, being already in the various motion requiſite to fluidity, yield more eaſily to the impellent, and alſo that being fully, or very near it, counterpoiſed by others of the ſame fluid, a ſcarce imaginably little force may ſuffice to impell them;

them; insomuch that, though the brass Scale of a balance, of divers inches in Diameter, may well be supposed to outweigh many myriads of such particles as compose water, wine, &c. yet, (as I elsewhere more fully relate) when such a scale was duly counterpoised with another like it, I could easily put it into various motions onely with the invisible *Effluvia* of no great piece of Amber. And if we consider that obvious Instance of the swelling Circles made by casting a stone into a Pond or other stagnant water, we shall be the more easily perswaded, that, even in a heavy fluid, a motion may reach a far greater way, than men are usually aware of, beyond the parts on which it was first impress.

On this occasion I must not omit a strange Observation given me by a very experienced Navigator, that much frequents the Coast of *Groenland*, and other *Arctick* Regions, to fish for whales. For this person being discoursed with by me about the effects

fects of the breaking of thoſe vaſt piles of Ice, that are to be met with in thoſe parts, aſſured me, that not onely he had often heard the Ice make in breaking terribler noiſe than the loudeſt claps of thunder with us, but that ſometimes, when the Sea-water had, as it were, undermined the foundation of the mountainous piece of Ice, he has known it at length ſuddenly fall into the ſubjacent Sea with ſo much violence as to make a ſtorm at a great diſtance off; inſomuch that once, when he lay two Leagues off of the place where this ſtupendious maſs of Ice fell, it made the waves goe ſo high as to waſh clear over the ſtern of the ſhip, with danger enough to ſome of his men, and to ſink ſeveral of his ſhallops that were riding by, though ſcarce any ſmall veſſels in the world uſe to be ſo fitted for rough Seas as thoſe about *Groenland.*

And whereas, though the Air be a much thinner fluid, we are apt to think it indiſpoſed to propagate motion

tion far, give me leave to tell you, that we may take wrong measures, if we think, that, (for instance) the undulating motion, into which the Air is put by the action of sonorous bodies, reaches but a little way, as we are apt to presume it does, because we judge of it by the effect it has on our ears when the sound is made in disadvantageous places. For one, that, for instance, hears a Lute or a Viol plaid on in a room furnished with hangings, will be apt to think the sound faint and languid in comparison of what it would appear to him, if the same Instrument were plaid on after the same manner in an arched room without hangings; these soft and yielding bodies being apt to dead the sound, which the figure and hardness of the Vaulted room would reflect. And so, when a man speaks aloud in the free Air, we are not wont to take any notice of a progress made by the motion of the Air beyond the place we are in, when our ears receive the sound; but if the place happen

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to be furniſhed with an *Echo*, though at many times that diſtance from the ſpeaker, we may then eaſily take notice, that the motion of the Air was carried on, and that with good vigour, to a far greater diſtance than elſe we ſhould have obſerved. And I have often thought, that, even by the better ſort of our Echoing places, we are not informed, to near how great a ſphere the motion, which the Air is put into by Sounds, may extend it ſelf, where its diffuſion and vigour are not hindred nor weakned by bodies either placed too near, or indiſpoſed to promote its operation.

What has been lately ſaid of the great diffuſion of Sounds, if themſelves be loud and great, will appear highly probable, by what is related by the Learned *Fromundus*, who being Profeſſour of Philoſophy at *Lovain*, in the Year 1627, had opportunity enough to know the Truth of what he relates; namely that, at the famous Siege of *Oſtend* in *Flanders*, the *From. Meteor. Lib. II. Art. 9.*

thunder of the great Ordnance was heard at above thirty Dutch Leagues, which, according to the vulgar reckoning, amounts to a hundred and twenty of our Engliſh miles. And that is yet, as he truly obſerves, more ſtrange, and makes more for our preſent purpoſe, which he adds concerning the diffuſion of the ſound of a Drum, which, he ſays, was, upon a time, heard at Sea twelve Leagues off.

But to return to what I was ſaying of *Echo's*, to confirm my conjecture about them, I ſhall think it needleſſe to offer you any other Argument, than that which you will draw your ſelf from the Notable Relation I met with in the Learned *Varenius* of an Obſervation made by *David Frælichius*, who, in the Company of a couple of Students, had the curioſity (in the month of *June*) to viſit the mountain *Carpathus*, eſteemed the higheſt of all the *Hungarian* Hills, and ſaid to be much more ſteep and difficultly ac-

Geograph. general. Lib. I. Cap. XIX.

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ceſſible than any of the *Alps* themſelves. *Frælichius* then (in my Authour) having related with what difficulty he and his Companions aſcended above that Region of the Air, where they met with clouds and vehement winds, adds this memorable Obſervation, for whoſe ſake I mention the ſtory: *Exploſi* (ſaies he) *in ea ſummitate ſclopetum, quod non majorem ſonitum primò præ ſe tulit, quàm ſi tigillum vel bacillum confregiſſem; poſt intervallum autem temporis murmur prolixum invaluit, inferioréſque montis partes, convalles, & ſylvas oplevit. Deſcendendo per nives annoſas intra convalles, cùm iterum ſclopetum exonerarem, major & horribilior fragor quàm ex tormento capaciſſimo indè exoriebatur: hinc verebar, nè totus mons concuſſus mecum corrueret; duravítque hic ſonus per ſemiquadrantem horæ, uſque dum abſtruſiſſimas cavernas penetraſſet, ad quas Aer undique multiplicatus reſiliit. Et talia quidem objecta concava in ſummitate ſe non illico offerebant, idcirco ferè inſenſibiliter*

primùm ſonus repercutiebatur, donec deſcendendo antris & convallibus vicinior factus, ad eas fortiùs impegit.

CHAP. VI.

Obſervat. V. *Men uſually think not what the modification of the inviſible motion of Fluids may perform on the diſpoſed bodies of Animals.*

IN this Obſervation I expreſly mention *the diſpoſed bodies of Animals*, to intimate, that there is a peculiar aptitude required in thoſe Animals, or ſome particular parts of them that are to be ſenſibly affected by ſuch motions as we are treating of, which would otherwiſe be too languid to have any ſenſible operation on them.

It ſeems the leſs ſtrange to me, that continuing Sounds, and other ſomewhat durable Impulſes of the Air or other Fluids, ſhould have a manifeſt operation upon Solid bodies, when I conſi-

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der the multitude of ſtrokes that may in a very ſhort and perhaps ſcarce obſervable time, be ſuppoſed to be given by the parts of the fluid to the Conſiſtent body. For, though each of theſe ſingle would perhaps be too languid to have any ſenſible effect at all; it being opportunely and frequently repeated by the ſucceſſive parts of the fluid, as by ſo many little ſwimming hammers or flying bullets, they may well have a notable effect upon the parts of a body expoſed to their action: As may be argued from the great ſwing that may be given to Pendulums by a very languid force, if it ſucceſſively ſtrike the ſwinging body, when having finiſhed its excurſion, 'tis ready to return towards the Perpendicular; as alſo from the tremulous motion that is imparted even to the metalline ſtring of a Muſical Inſtrument, by the congruous motion the Air is put into by another trembling ſtring, (as there may be hereafter occaſion to declare.)

I remember, *Scaliger* tells a plea-

ſant ſtory of a Knight of *Gaſcony*, whom the ſound of a Bagpipe would force preſently to make water; adding, that a Perſon diſobliged by this man, and reſolving to be merrily revenged on him, watched a time when he ſate at a Feaſt ſo as he could not well get out, and brought a Bagpiper to play unawares behind him; which he did ſo unluckily, that the Muſick had preſently its wonted effect upon the poor Knight, to his great Confuſion and the laughter of the Company. On which occaſion I ſhall add, that I know a very Ingenious Gentleman, who has confeſſed to me, that the noiſe of a running Tap is wont to have almoſt the like operation upon Him.

'Tis a common Obſervation, that the noiſe that an ungreaſed cart-wheel makes in grating againſt the axel-tree, and the ſcraping of a knife upon a plate of ſilver or pewter, and ſome other ſuch brisk and acute Sounds, do ſo affect divers parts of the Head, as to produce that effect

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that is commonly called *ſetting the Teeth on edge*; which whether it proceed from any commerce between the Auditory Nerves, and thoſe that are inſervient to the motion we have mentioned, I leave Anatomiſts to conſider. But theſe effects of acute ſounds are much leſs conſiderable than that which I elſewhere relate of an Ingenious Domeſtick of mine, who ſeveral times complained, that the tearing of brown paper made his Gums bleed: which argued that the ſound had an operation not onely upon the nervous and membranous parts, but the bloud and Humours themſelves.

Sir *Henry Blunt*, in his voiage to the *Levant*, giving an account of what he obſerved in *Egypt*, has, among other remarkable things, this paſſage: Many rarities of Living creatures I ſaw in *Gran Cairo*, but the moſt ingenious was a neſt of four-legged Serpents of two foot long, black and ugly, kept by a Frenchman, who when he came to handle them, they would not endure him, but ran and hid

in their hole; then would he take his Cittern and play upon it: They, hearing his Musick, came all crawling to his feet, and began to climbe up him, till he gave over playing, then away they ran.

This recalls to my mind, what some men of repute, and particularly the Learned *Kircherus*, relate concerning a great Fish, in or about the Streights that sever *Sicily* from *Italy*, which is said to be much affected with a peculiar kind of Tune, (harsh enough to Humane ears) by which the Mariners are wont to allure it to follow their vessels. And it may much strengthen the Conclusion maintained in this Chapter, if there be any certainty in the famous tradition, that the Lion is terrified and made to run away by the crowing of a Cock: I say, *if*, because though I doubt not but some peculiar kinds of Sounds, as well as of other sensible objects, may be particularly and exceedingly ungratefull to the Sensories of this or that peculiar kind of Animals, and consequently

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to the ears of Lions; yet a late French Traveller into the *Levant* gives me cauſe much to queſtion the matter of fact, affirming, that rowing along the brink of *Tigris* or *Euphrates*, (for I do not punctually remember which,) they were, for many hours in the night, terrified by Lions that attended them along the brink of the River, and would not at all be frighted by the frequent crowing of the Cocks that chanced to be in the paſſengers Boat. Of which unconcernedneſs of the Lions, our obſerving traveller took much more notice than the Lions appeared to do of the crowing of the Cocks. I might on this occaſion ſay ſomething of the received Tradition, that many ſleeping perſons will be more eaſily waked by being called upon by their own uſual names, than by other names, though uttered with a louder voice. But this it may ſuffice to have mentioned; nor will I here inſiſt on that more certain example of the operation of a Sound, which is afor-

forded by the ſtarting of men or greater Animals, upon a ſurprizing, though not vehement, noiſe; though this oftentimes puts ſo many of the Spirits and Muſcles into motion, that the whole bulk of the Animal is ſuddenly raiſed from the ground, which perhaps it could not be by the bare counterpoiſe of ſome hundreds of pounds: This, I ſay, I will not in this place inſiſt on, becauſe the *Phænomenon* ſeems to depend rather upon the loudneſs or acuteneſs of the ſound, than upon any determinate modification of it, particularly relating to the *Animal* it ſelf.

But the eminenteſt Inſtance of the efficacy of peculiarly modified Sounds upon diſpoſed bodies, is afforded by what happens to thoſe which are bit by a *Tarantula*. For though the bitten perſon will calmly hear divers other tunes, yet when a peculiarly congruous one comes to be plaid, it will ſet him a dancing with ſo much vigour as the ſpectators cannot but wonder at, and the dancing will

ſome-

ſometimes continue many hours, if the Muſick do ſo, and not otherwiſe. I know there are ſome that queſtion the truth of the things related of theſe *Tarantati*, (as the *Italians* call them,)and I eaſily grant,that ſome Fictions may have been ſuffered to paſs under the countenance of ſo ſtrange a Truth. But beſides the affirmations of ſome Learned men, (as well Phyſicians as others) my Doubts have been much removed by the Accounts I have received from an Ingenious Acquaintance of mine own,who at *Tarentum* it ſelf, whence the Inſect takes its name, and elſewhere,ſaw many bitten perſons in their dances,ſome in publick and ſome in private places, and amongſt the reſt a Phyſician, on whom the tune that fitted his diſtemper had the ſame operation as on the other Patients. And the Learned *Epiphanius Ferdinandus*, who practiſed Phyſick in *Apulia* and *Calabria* for many years, not onely delivers upon his own perſonal obſervation, ſeveral Narratives of the effects

effects of Muſick upon the *Tarantati*, but invites any that may doubt of the truth of ſuch Narratives to repair to him at a fit ſeaſon, undertaking to convince them by ocular Demonſtration.

I know a very honeſt and ſober Muſician, who has divers times affirmed to me, that he could at pleaſure, by playing a certain Tune, (which he acquainted me with, and which did not much move others) make a perſon (whom he named to me) weep, whether ſhe would or no. And I might add, that when I have been taking Phyſick, or am anything feveriſh, the repetition of two verſes of *Lucan* ſeldom fails (as I have often tried) of producing in me a chilneſs, almoſt like that, but fainter, that begins the fit of an ague. But on this Inſtance I look not as a ſtrong proof of the Phyſical efficacy of Sounds; becauſe thoſe two verſes having been emphatically read, when divers years agoe I lay ſick of a ſlow fever, and could not reſt, they made

ſo ſtrong an impreſſion on me, that whenever I am under a Diſcompoſure any thing near like that, that then troubled me, thoſe verſes revive, as'twere, in my brain and ſome other parts that diſpoſition, or rather indiſpoſition, with which my firſt hearing of thoſe verſes was accompanied.

It may be the leſs admired, that the vibrating motion of the Air, that produces ſounds, ſhould have ſuch effects upon diſpoſed Organical bodies, ſince Light it ſelf, which either conſiſts of briskly moving *effluvia* far more ſubtile than aerial corpuſcles, or is propagated by the pulſe of a far more ſubtile body than Air, may have a notable operation upon diſpoſed bodies. For we commonly obſerve, that the Sunbeams, by beating upon the face or eyes of ſome that come ſuddenly out of a ſhaded place into the Light, preſently make them ſneeze; which you know is not done without a vehement motion of divers parts of the

the body. And though Colour be but a modification of Light; yet, beſides that 'twas anciently a practice, as the Hiſtory of the *Macchabees* informs us, to ſhew red objects to Elephants, to make them more fierce, 'tis a familiar obſervation, that red cloaths do offend and irritate Turky-cocks. And that is more remarkable, which is related by the very Learned Phyſician *Valeſius*, of a perſon that he knew, who, if he looked upon red objects, would not onely have his Eyes offended, but was ſubject to an effuſion of Humours in the neighboring parts.

CHAP.

CHAP. VII.

Obſervat. VI. *Men ſuſpect not what efficacy the Inviſible motions of Fluids may have, even upon inorganical bodies, upon the ſcore of ſome determinate Congruity or relation betwixt a peculiar Texture of the one, and the peculiar modification of the others motion.*

THough the Experiments delivered in the foregoing Chapter have, I preſume, ſufficiently manifeſted, that the modification given to the motions of the Air by ſonorous bodies may have conſiderable effects upon Animals, in whoſe organized bodies the curiouſly contrived parts have an admirable connexion with, and relation to, one another, and to the whole Symmetrical fabrick they make up; yet, I fear, it will ſcarce ſeem credible, that ſonorous motions of the Air, not very loud, ſhould find, even in bodies

bodies Inanimate and Inorganicall, ſuch congruous Textures and other Diſpoſitions to admit their action, that even more languid Sounds, peculiarly modified, may ſenſibly operate upon them, and much more than ſounds that are louder and more vehement, but not ſo happily modified. To make this good by particular Experiments, I ſhall begin with that, which, though the effect may ſeem inferiour to that of moſt of the others, I judge fitteſt to manifeſt, that the produced motion depends upon the determinate modification of that of the impellent Fluid.

That a certain impulſe of Air, made by one of the Uniſon-ſtrings of a Muſical Inſtrument, may ſuffice to produce a viſible motion in another, is now become a known experiment; of the Cauſe and ſome unobſerved Phænomena of which I elſewhere more fully diſcourſe. But, that it may not be ſuſpected in this caſe, that the ſhake of the untouched ſtring is communicated to it by the propa-

propagated motion of the Inſtrument it ſelf, to which the ſtring, that is ſtruck, is alſo faſtned; I ſhall add, that, according to what I elſewhere relate, I found by trial purpoſely made, that a ſtring of Wire, (which you will grant to be a more ſolid body than an ordinary Gut-ſtring,) may be without another ſtring brought to tremble by a determinate Sound made at a diſtance, which produced but ſuch an impulſe of the Air, as could neither be ſeen nor felt by the By-ſtanders, nor would communicate any ſenſible motion to the neighbouring ſtrings. 'Tis true, that in this caſe the ſtring, in which the trembling was produced, was a ſingle, long, ſlender and ſpringy body, faſtned at both ends to a ſtable one; and therefore it may ſeem altogether groundleſs to expect, that any thing like this effect ſhould be by the ſame cauſe produced in bodies that do not appear ſo qualified. But, as we elſewhere ſhew, that a certain degree or meaſure of tenſion is in or-

der to this Phænomenon the principal Qualification, without which all the other would be unavailable; perhaps 'twill not be abſurd to enquire, *whether*, in bodies of a very differing appearance from ſtrings, the various Textures, Connexions, and Compli-cations, that Nature or Art, or both, may make of the parts, may not bring them to a ſtate equivalent to the Tenſions of the ſtrings of Muſical Inſtruments, whereby divers of the mentioned parts may be ſtretched in the manner requiſite to diſpoſe them to receive a vibrating motion from ſome peculiar Sounds: And *whether* theſe trembling parts may not be nu-merous enough to affect their neigh-bours, and make, in the body they belong to, a tremulous motion di-cernible, though not by the Eye, yet by ſome other ſenſe. This conjecture or inquiry you will, I hope, have the leſs unfavourable thoughts of when you ſhall have conſidered the following Experiments.

I remember, that many years ago I found

I found by trial, that, if a ſomewhat large and almoſt hemiſpherical Glaſſe, though not very thin, were conveniently placed, a determinate ſound, made at a convenient diſtance from the concave ſurface of the Glaſſe, would make it ſenſibly ring, as a Bell does a while after it has been ſtruck. But this noiſe was the effect of a determinate ſound; for, though the voice were raiſed to a higher tone, or if the ſound were made louder, the ſame effect would not inſue. I remember alſo, that, ſome years after, I obſerved, that large empty drinking-glaſſes of fine white metal had each of them its determinate Tenſion, or ſome diſpoſition that was equivalent as to our purpoſe. For, cauſing the ſtrings of a Muſical Inſtrument to be variouſly ſcrewed up, and let down, and briskly ſtruck, we found, as I expected, that the motion of one ſtring, when 'twas ſtretched to a certain note or tone, would make one of the Glaſſes ring, and not the other; nor would the ſound of the

ſame ſtring, tuned to another note, ſenſibly affect the firſt Glaſſe, though perhaps it might have its operation upon another. And this Circumſtance is not, on this occaſion, to be omitted, that, after we had found the tone proper to one of the Glaſſes, and ſo tuned the ſtring, that, (I ſay) when that was ſtruck, the Glaſſe would reſound. Having afterwards broken off a part of the foot of the glaſs, yet not ſo much but that it continued to ſtand upright, the ſame ſound of the ſtring would no longer be anſwered by the Veſſel, but we were obliged to alter the tenſion of the ſtring, to produce the former effect. The Learned *Kircherus*, as I have been informed, ſomewhere mentions a correſpondence between ſome liquours and ſome determinate ſounds; which I ſuppoſe may be true, though the triall did not ſucceed with me, perhaps for want of ſuch accommodations for ſo nice an Experiment as I could have wiſhed, but could not procure: But if you can, you will oblige

lige me to make the trials ſo as to ſatisfie your ſelf and me, whether the agitation of the liquour be cauſed immediately by the motion of the Air, or be communicated by the intervention of the tremblings of the Veſſel.

An Artiſt famous for his skill in making Organs, anſwered me, that, at ſome ſtops of the Organs, ſome ſeats in the Church would tremble. But, becauſe I ſuſpected by his Relation, that the greatneſs of the ſound chiefly effected it, becauſe, when that Pipe, which they call the open *Diapaſon*, ſounds, the chair or ſeat, on which the Organiſt ſits, and perhaps the neighbouring part of the Organ trembles; I ſhall add, that I have divers times obſerved certain ſounds of an excellent Organ to make not onely the ſeat, I ſate on in the Church, tremble under me, but produce an odd tremulous motion in the upper part of my Hat, that I could plainly feel with my hands. And that, which makes me apt to believe that this effect depends upon the de-

terminate tone, rather than upon the loudneſs of the ſound, is, that I have oftentimes felt, and diligently obſerved ſuch a kind of motion in the upper part of my Hat, upon the pronouncing of ſome words in ordinary diſcourſe; in which caſe the effect could not with probability be referred to the greatneſs of the Sound, but its peculiar fitneſs to communicate ſuch a motion to a body ſo diſpoſed.

Nor is it onely in ſuch ſmall and yielding bodies, as Hats and Strings, that Sounds that are not boiſterous may produce ſenſible effects, for, if they be congruous to the Texture of the body they are to work on, they may excite motions in it, though it be either ſolid or very bulky: of which I ſhall here ſubjoyn a couple of inſtances.

An ancient Muſician affirmed to me, that, playing on a Baſe-viol in the chamber of one of his Scholars, when he came to ſtrike a certain Note on a particular ſtring, he heard an odd kind of jarring Noiſe, which he thought

thought at firſt had either been caſual, or proceeded from ſome fault in the ſtring; but, having afterwards frequent occaſion to play in that ſame room, he plainly found, that the Noiſe, he marvelled at, was made by the tremulous motion of a Caſement of a window, which would be made to tremble by a determinate ſound of a particular ſtring, and not by other Notes, whether higher or lower.

To this firſt Inſtance I ſhall add the ſecond, which, I confeſſe, I was not forward to believe, till trial had convinced me of the Truth; and I ſcrupled it the rather, becauſe, if the reflexion of determinate Sounds ſhould appear to proceed from the peculiar kind of tremulous motion into which the parts of the reſonant body are put, it may incline men to ſo great a Paradox, as to think, that ſuch a motion of the Air as our Bodies do not feel, may produce a trembling in ſo ſolid a body as a Stone-wall of a great thickneſs. The Experiment or Obſervation it ſelf I ſhall give you

in the ſame words I ſet it down ſome hours after I made it, which were theſe.

Yeſterday I went to ſatisfy my ſelf of the truth of what had been told me by an ancient Muſician, to whom I had been relating what I had obſerved of the effects of ſome determinate Sounds even upon Solid bodies, and of whom I enquired, if he had met with any thing of the like nature: taking him along with me, I found, that though the place be but an Arch, yet it would not anſwer to all notes indifferently, when we ſtood in a certain place, but to a determinate Note, (which he afterwards told me was *Ce fa ut* a little flatted,) to which note it anſwered very reſonantly, and not ſenſibly to others, which we made trial of, whether higher or lower than it; and, (which added to the ſtrangeneſs,) when I made him raiſe his voice to an Eighth, as conſonant as thoſe two Sounds are wont to be in all other caſes, the vaulted Arch did not appear

pear to us affected with the Note. The Muſician added, that he had tried in moſt Arches all about the City, and could not find ſuch a peculiarity in them, as being to be made reſonant by all Notes or Sounds indifferently that were ſtrong enough; and alſo, that as this Arch for this hundred years has been obſerved to have this property, ſo an ancient and experienced Builder informed him, that any Vault that were exquiſitely built, would peculiarly anſwer to ſome determinate Note or other.

CHAP.

CHAP. VIII.

Obſervat. VII. *Men look upon divers Bodies as having their parts in a ſtate of abſolute Reſt, when indeed they are in a Forced ſtate, as of Tenſion, Compreſſion,* &c.

THis Obſervation will probably ſeem paradoxicall. For, when an intire Body, eſpecially if it be of a ſolid Conſiſtence, and ſeem to be of an homogeneous or uniform matter, appears to be moveleſſe, we are wont to take it for granted, that the parts, which that body is made up of, are perfectly at Reſt alſo. But yet this will ſcarce be thought a reaſonable ſuppoſition, if we do but rightly conſider ſome obvious *Phænomena*, which may teach us, that, whilſt a whole Body, or the ſuperficies that includes it, retains its figure, dimenſions and diſtance from other ſtable Bodies that are near it, the Corpuſcles that compoſe it may have various

various and brisk motions and endeavours among themſelves. As, when a bar of iron or ſilver, having been well hammered, is newly taken off of the Anvill; though the Eye can diſcern no motion in it, yet the touch will readily perceive it to be very hot, and, if you ſpit upon it, the brisk agitation of the inſenſible parts will become viſible in that which they will produce in the liquour. Beſides, when the Lath of a Croſs-bow ſtands bent, though a man do neither by the Eye nor the Touch perceive any motion in the ſpringy parts, yet if the ſtring be cut or broken, the ſudden and vehement motion of the Lath, tending to reſtore it to the figure it had before it was bent, diſcovers a ſpringineſs; whence we conclude it was before in a ſtate of violent Compreſſion. And, though the ſtring of a bent Bow do likewiſe appear to be in a ſtate of Reſt; yet, if you cut it aſunder, the newly made extreams will fly from one another ſuddenly and forcibly enough

to

to manifeſt, that they were before in a violent ſtate of Tenſion. And on this occaſion I could add divers Inſtances taken not onely from the works of Art, but thoſe of Nature too, if they did not belong to another paper: But, one ſort of Obſervations 'twill be proper to ſet down in this place; becauſe in thoſe already mentioned, the bow and ſtring were brought into a violent ſtate by the meer and immediate force of man. I ſhall therefore add, that there are divers bodies, in which, though no ſuch kind of force appears to have antecedently acted on them, we may yet take notice of a ſtate of violent Compreſſion or Extenſion, and a ſtrong endeavour or tendency of the parts, that to the Eye or the Touch ſeem at reſt, to ſhrink or to fly out; and this endeavour may in ſome Caſes be more laſting and more forcible than one would eaſily ſuſpect or believe. But examples of this kind you muſt not expect that I ſhould give you out of *Claſſick* Authours,

thours, ſince in them 'tis like you have not met with either an Inſtance or a Conjecture to this purpoſe; but ſome few things that I tried my ſelf, and ſome others that I learnt by Inquiry from ſome Tradeſmen, whom I judged likelieſt to inform me, I ſhall briefly acquaint you with.

I have ſometimes obſerved my ſelf, and have had the Obſervation confirmed to me by the ingeniouſer Traders in Glaſs; That a Glaſs, that ſeemed to have been well baked, or nealed, (as they call it) would ſometimes, many days or weeks, or perhaps months, after it is taken from the fire, crack of its own accord; which ſeems for the moſt part to happen upon the ſcore of the ſtrong, but unequall, ſhrinking of the parts of the Glaſſe. And the Glaſs-men will tell you, that, if they take their Glaſſes too haſtily from the fire, not allowing them leiſure to cool by degrees, they will be very apt to crack. But I remember, that, to ſatisfy ſome Ingenious

genious men, I deviſed a way of exhibiting a much more quick and remarkable *Phænomenon* of that kind. Having made then, by a way I elſewhere teach, a flat Lump of metalline Glaſs, two or three or four times as thick as an ordinary Drinking-glaſs, I obſerved, as I expected, that, though it had been melted in a very gentle fire, its very fuſible nature needing no other, and though it were removed but very little from the fire, it was ſo diſpoſed to ſhrink upon a ſmall degree of Refrigeration, or rather abatement of Heat, that, before it was ſenſibly cold, it would crack with a noiſe in ſo vehement a manner, that, notwithſtanding the ponderouſneſs of the matter, which had been purpoſely laid upon a Level, parts of a conſiderable bulk, weighing perhaps ſome Drams, would fly, to a not inconſiderable diſtance from one another. And this Experiment I took pleaſure to make more than once. And if you will be content with an Inſtance

which, though otherwiſe much inferiour, may not be unwelcome, for its being eaſily and readily made; I ſhall offer you one that I have often repeated. Take a piece of Copper, (if the Plate be thick, 'tis ſo much the better,) and, having throughly brought it to a red or white Heat among kindled Coals, take it from the fire, and when it begins to cool a little, hold it over a ſheet or two of white Paper, and you will perceive good ſtore of flakes to fly off, not without ſome little noiſe, one after the other, and ſometimes perhaps as far as the farthermoſt edges of the paper; which flakes or ſcales ſeem by their brittleneſs and colour, to be but parts of the ſurface of the metal vitrified by the vehement action of the fire, and afterwards by a too haſty refrigeration ſhrinking ſo violently, as to crack and leap from one another, like the contiguous parts of the ſtring of a Viol or other Muſical Inſtrument, that breaks by the moiſture of the Air. And on this

this occaſion I ſhall add, that, having afterwards inquired of an expert Artificer, that made metalline Concaves, about the ſhrinking of his mixtures of metalls, he confeſſed to me, that he uſually obſerved them to ſhrink upon Refrigeration. And the like I my ſelf have obſerved in Iron of a great thickneſs, and purpoſely fitted to a hollow body of metall, which it would not enter when it was ignited, though it would when 'twas cold. But to ſhew you by a notable Inſtance or two, both that Metals may ſhrink, and that they may doe ſo with a very conſiderable force, I ſhall add, that I found by inquiry, that the lately mentioned Artificer, after he had made ſome large Concaves of an unfit mixture of metals, and having removed them from the fire, had been very carefull to keep the cold Air from them, leſt they ſhould cool too haſtily, obſerved yet to his great loſs, that, when they came to be further refrigerated, they would (perhaps after three hours) crack with a great noiſe, though

though this metalline mixture were perchance harder than Iron, and three or four times as thick as common Looking-glaſſes. But the misfortune of another Tradeſman afforded me a yet more conſiderable *Phænomenon*. For this excellent Artificer, whom I often employ, and with whom I was a while ſince diſcourſing of theſe matters, complain'd to me, that, having lately caſt a kind of Bell-metall upon a very ſtrong ſolid Inſtrument of Iron of a conſiderable ſuperficial *Area*, though the metal were ſuffer'd in a warm room to cool, from about eight a clock on Saturday night till about ten or twelve on Monday morning, and were then (which is to be noted) conſiderably hot to the touch; yet it cool'd ſo far, that, ſhrinking from the Iron that would not ſhrink with it, the Bell-metall cracked in divers places with noiſes loud as the Report of a Piſtoll, though the metall, he affirm'd to me, was an inch and half, or two inches thick. And the ſame

perſon ſhewed me a large Cylinder of Iron, about which, for a certain purpoſe, a Coat of Bell-metall had been caſt ſome days before, on which (Bell-metall) there was a crack near one end made by the coldneſs of the Iron, though the thickneſs of the Bell-metall, as near as I could meaſure it, exceeded an inch, and (as the Workman affirmed) an inch and a quarter.

Nor is it onely in ſuch mixtures as Bell-metall, which, though very hard, may be very brittle, but even in a metal that is malleable when cold, that the like Phænomenon may be met with, as I have been aſſured by another ingenious Artificer, of whom I inquired, whether he had taken notice of the ſhrinking of metalls; who affirm'd to me, that, having had occaſion to caſt about a Cylinder of Iron a ring or hoop of Braſs, he found to his trouble, that, when the metall began to cool, the parts ſhrunk from one another ſo as to leave a gaping crack, which he was fain to

fill

fill up with ſoulder quite croſſe the breadth of the ring, though this were above an inch thick.

I ſhould not, *Pyrophilus*, have in this Chapter entertained you with more Experiments of others than of my own, if I had the conveniency of living near Founders of metalls, as the Tradeſmen had whoſe Obſervations I have recited, and whoſe ſincerity in them I had no cauſe to queſtion. And both their Experiments and mine ſeem to teach, that a body may be brought into a ſtate of Tenſion, as well by being expanded and ſtretch'd by the action of the fire upon the minute parts, as by the action of an external Agent upon the intire body. And, to ſpeak more generally, the ſtate of violent Contraction and Compreſſion may not unfitly be illuſtrated by a Bow that is bent. For, as the Bow it ſelf is brought to a ſtate of Compreſſion by the force of the Archer, that bent it; ſo by the Elaſtical force of the bent Bow, the ſtring is brought into a violent ſtate

of Tenſion, as may be made evident by the cutting off the ſtring in the middle; for then both the Bow will fly ſuddenly outwards, and the parts of the ſtring will ſwiftly and violently ſhrink from one another. And according to this Doctrine, the effect of other bodies upon ſuch as are thus brought into, what men call, a Preternatural ſtate, is not to be judg'd barely according to uſual meaſures, but with reſpect to this latent Diſpoſition of the Patient: as, for inſtance, though the ſtring of a Viol not ſcrew-ed up, will not be hardned by the vapours that imbue the Air in moiſt weather; yet a neighbouring ſtring of the ſame Inſtrument, though perhaps much ſtronger, being ſcrew'd up, and thereby ſtretched, will be ſo affected with thoſe vapours, as to break with noiſe and violence. And ſo when one part of a piece of Glaſs is made as hot as can be, without appearing diſcolour'd to the Eye, though a drop or two of cold water have no effect upon the other part of

the ſame Glaſſe, yet if it touch the heated part, whoſe wonted extenſion (as I have elſewhere proved) is alter'd by the fire that vehemently agitates the component particles, the cracking of the Glaſs will almoſt always preſently enſue.

If againſt theſe Inſtances it be alledged, that it is poſſible to aſſign another cauſe of the ſeemingly ſpontaneous breaking of the bodies mention'd in this Chapter, than that which I have propos'd, it will not much concern this Diſcourſe to examine the Allegation; for, whatever the latent Cauſe of the Phænomena may be, the manifeſt Circumſtances of them ſuffice to ſhew, that bodies, which, as to ſenſe, are in a natural ſtate of Reſt, may be in a violent one, as of Tenſion, and may have, either upon the ſcore of the contexture of the parts among themſelves, or upon that of ſome interfluent ſubtile matter, or ſome other Phyſical Agent, a ſtrong endeavour to fly off or recede from one another; and that,

in divers bodies, the cauſe of this endeavour may act more vigorouſly than one would eaſily believe: and this ſuffices to ſerve the turn of this Diſcourſe. For I preſume that a perſon of your Principles will allow, that Local Motion muſt be produc'd by Local Motion, and conſequently, that, without a very ſtrong, though inviſible and unheeded one, ſuch hard and ſolid bodies as thick pieces of metall could not be made to crack.

I know not whether I may on this occaſion acquaint you with an odd Relation I had from a very honeſt and credible, as well as experienced, Artiſt, whom I, for thoſe reaſons, have ſeveral times made choice to deal with about precious Stones, and other things belonging to the Jewellers and Goldſmiths trades. For, conſidering with him one day a large lump of matter, which contained ſeveral Stones that he took for courſe Agats, and which were joyned together by a Cement, that in moſt places was harder than moſt ordinary

ry Stones, I perceived that there remained divers pretty large cavities in this Cement, which ſeemed to have contained ſuch Stones as thoſe that yet made parts of the lump. Upon which occaſion he affirmed to me, that ſeveral of the Stones grew whilſt they were lodg'd in thoſe cavities. And when I told him, that, though I had been long of an opinion, that Stones may receive an increment after their firſt formation, yet I did not ſee how any ſuch thing appeared by thoſe we were looking upon: He gave me in many words an account of his Aſſertion, which I reduced to this, that the Stones he ſpoke of, did, after they were firſt formed, really tend to expand themſelves by virtue of ſome Principle of growth, which he could not intelligibly deſcribe; but that theſe Stones being lodg'd in a Cement extreamly hard, and therefore not capable of being forced to give way, their expanſive endeavour was rendered ineffectual, but not deſtroyed: ſo that when afterwards theſe

Stones came to be taken out of the Cement wherein they were bedded, and to whoſe ſides 'tis like they were not exquiſitely congruous, the compreſt Stones, having their ſides now no longer wedged in by the harder Cement, quickly expanded themſelves, as if 'twere by an internal and violently compreſt ſpring, and would preſently burſt aſunder, ſome into two, and ſome into more pieces: of which he preſented many to his friends, but yet had reſerved ſome, whereof he preſented me one, that I have yet by me, together with ſome of the maſs, whoſe Cement I find to bear a better poliſh than marble, and to be very much harder than it. And, in anſwer to ſome queſtions of mine, he told me, that he had taken up theſe Stones himſelf, naming the place to me, which was not very far off, and that he obſerved all that he told me himſelf, and more than once or twice, and that I needed not ſuſpect, as I ſeemed to doe, that 'twas the ſtrokes employed to force the Stones

Stones out of their Beds, that made them break. For, beſides that many of them, which (it ſeems) were not compreſt enough, did not break, ſeveral of thoſe, that did, were taken out, without offering them any ſuch violence, as that their burſting could with any probability be imputed to it.

CHAP.

CHAP. IX.

Obſervat. VIII. *One main cauſe why ſuch Motions as we ſpeak of are over-look'd, is, That we are ſcarce wont to take notice but of thoſe motions of Solid bodies, wherein one whole Body drives away another, or at leaſt knocks viſibly againſt it, whereas many effects proceed from the inteſtine motions produced by the external Agent, in, and among, the parts of the ſame body.*

THis Obſervation is like to be much more readily underſtood than granted, and therefore I ſhall offer by way of proof the following Experiments.

We cauſed in a large braſs Stop-cock the movable part to be nimbly turned to and fro in the contiguous cavity of that part that was made to receive it, in that part of the Inſtrument that is wont to be kept fixt. And though this motion of the Key were

were made onely by the bare hand, yet in a ſhort time the mutual attrition of the contiguous parts of the Inſtrument made ſo brisk an agitation in the other parts, that the incaleſcence made the metal it ſelf to ſwell, inſomuch that the Key could no more be turned, but remained fixt, as if it had been wedged in, ſo that, to make it work as before, it was neceſſary by cooling it to make it ſhrink a little, and ſo take off the mutual preſſure of the Key, and the other part of the Stop-cock. Nor is this to be looked on as a caſual Experiment; for, beſides that it was made more than once, and is very analogous to ſome other trials of mine; I found, that a maker of ſuch Inſtruments complained to me, that he was ſeveral times forced to intermit his work, and plunge his Inſtrument in cold water, before he could, by grinding, adjuſt the Key to the cavity it ought to fit.

I preſume I need not take notice to you, that this Experiment confirms what

what I elsewhere mention of the dilatation of metals themselves by Heat, and therefore I proceed to the next Instance.

This is afforded by the known Experiment of passing one's wetted finger upon the orifice of a Drinking-glass almost fill'd with water. For, though the Eye does not immediately discern any motion, that, by reason of the pressure of the finger, is made by one part of the glass upon another; yet, That a vibrating motion is thereby produced, may be argued by the dancing of the water, especially that which is contiguous to the prest sides of the glass, by which 'tis oftentimes so agitated, that numerous drops are made to leap quite over, and others are tossed up to a good height into the Air. And that there may be considerable motions in the sides of the glass, whilst it does not break in pieces, we may probably guess by this, that, in Drinking-glasses artificially cut by a spiral line, both I, and others, have often

often found by trial, that, a glaſs being dextrouſly inverted and ſhaken, the parts will vibrate up and down ſo manifeſtly, as ſometimes to lengthen the glaſs, by my eſtimate, a quarter of an inch or more, and yet, the glaſs being ſet again upon its foot, it appeared that it had not been hereby at all injured.

That two pieces of Iron or Steel, by being ſtrongly rubbed againſt one another, will at length acquire a temporary Heat, is not hard to be believed: but that an edg'd Tool of hardened Steel ſhould, by having its edge rubbed againſt, have a manifeſt and permanent change made in its Texture, you did not perhaps ſuſpect; and yet, having had the Curioſity to cauſe ſome metals, and particularly Iron and Steel, to be turned by an excellent Artificer, I learned partly by his experience, and partly by my own, that the edge of the Steel-tool, with which he by degrees ſhaved off the protuberant parts of the metal, would be ſo heated and agitated, that,

that, in no long time, if care were not taken to prevent it, the tool would be brought to look of blewiſh and yellowiſh colours, and, permanently loſing its former temper, would become ſo ſoft, as to be uſeleſſe for its former work, unleſſe it were again artificially hardened: and therefore, to prevent the trouble of tempering his tools again, this Artiſt, from time to time, dipt it, when it began to grow too hot, into a certain liquour, which he affirms, upon much experience, to have a peculiar fitneſs for that purpoſe.

Nor is it always neceſſary that the body, that makes the parts of an inanimate body work conſiderably on one another, ſhould be either very hard, or impetuouſly moved. For, I remember, that, having once by me ſome ſhort bars of fine Tin, I reſolved to try whether, meerly with my naked hands, (which you know are none of the ſtrongeſt or hardeſt,) I could not procure a conſiderable internal Commotion among the parts;

and

and accordingly, laying hold on the two ends of the bar with my two hands, I ſlowly bent the bar towards me and from me two or three times, and having by this means broke or cracked it in the midſt, I perceived, as I expected, that the middle parts had conſiderably heated each other.

What uſe may be made of this Experiment in the ſearch of the hidden cauſe of Elaſticity, would be leſs properly conſidered in this place than in another. But ſince I have named that Quality, I ſhall take this riſe to intimate, that if the reſtitution of a ſpringy body, forcibly bent, proceed onely (as ſome Learned Moderns would have it) from the endeavour of the compreſt parts themſelves to recover their former ſtate, one may not impertinently take notice of the Elaſticity that Iron, Silver and Braſs acquire by hammering, among the Inſtances that ſhew what in ſome caſes may be done by a motion wherein the parts of the ſame body are, by an

an almoſt unheeded force, put to act upon one another. But if Springineſs depend chiefly upon the pervaſion of a ſubtile matter, as the *Carteſians* would have it, then the Inſtances will properly belong to another Subject.

§ The foregoing Examples may alſo ſuffice to make out (what I am unwilling to refer to another Head) this ſubordinate Obſervation, That men are more uſually than juſtly prepoſſeſſed with an opinion, that nothing conſiderable is to be expected from the motion of a body againſt another, unleſs the former do make a manifeſt percuſſion or truſion of the latter. But, becauſe this prepoſſeſſion eſpecially prevails in caſes where the body that is by friction or attrition to affect the other, is it ſelf ſoft or yielding, I ſhall on this occaſion add a few Inſtances to remove this Prejudice.

An Artiſt, eminent for grinding of Optical glaſſes, confeſſed to me, that ſometimes when he went about to

to poliſh his broader glaſſes, though but upon a piece of Leather ſprinkled with Puttee, that friction did ſo heat or otherwiſe agitate the parts of the glaſs, as, to his great loſs, to make it crack from the edge to the middle; which ſeemed the more ſtrange, becauſe we ſee, what intenſe degrees of Heat glaſſes will endure without cracking, if the fire be but gradually applied, as this Artiſt's glaſſes muſt have been gradually heated.

But I think it worth inquiry, whether in this caſe the whole work be performed by meer Heat, and whether there intervene not a peculiar kind of motion, into which ſome bodies are diſpoſed to be put by a peculiar kind of friction, which ſeems fitted to produce in manifeſtly ſpringy bodies, and perhaps in ſome others, (of which divers may be ſpringy that are not commonly taken to be ſo,) ſuch a vibrating or reciprocal motion, as may have ſome notable effects, that are not wont to be produced by

moderate Heats, nor always by intenſe ones themſelves. The trembling of the parts of a Drinking-glaſs, and the viſible vibration of the long and great ſtrings of a Baſe-viol, upon peculiar ſounds, may give ſome countenance to this conjecture. And that in ſome bodies there may be ſuch a tremulous motion produced, by rubbing them upon ſo ſoft a thing as Wool, or upon a piece of Cloath, I tried by this Experiment:

We caſt into a hollow Veſſel, very ſmooth within, and of an almoſt Hemiſpherical figure, ſeverall ounces of good melted Brimſtone, and having ſuffered it to cool, and taken it out, the Convex ſurface, as had been deſired, came off well poliſhed; then this conveniently ſhaped lump, which had (if I well remember) four or five inches in Diameter, being briskly rubbed in the ſame line forwards and backwards, upon a Cuſhion or ſome ſuch woollen thing, in a place free from other noiſes, I could, by holding my ear to it, and attentively liſtening,

ſtening, plainly hear a crackling noiſe made by the agitated parts, which continued a brisk, and, as I ſuppoſed, a vibrating motion for ſome time after the friction was ended.

That there may be a conſiderable Commotion produced among the internal parts of bodies, by rubbing them even againſt ſoft bodies, I have divers times obſerved, by the ſulphureous ſteams that I could ſmell, if, after having a little rubbed a lump of good Sulphur upon my Cloaths, I preſently held it to my noſe. Which brings into my mind, that I have had the like effect from much harder and cloſer bodies than Sulphur, when they were rubbed upon bodies that were ſo too. For having purpoſely taken hard Stones cut out of mens Bladders, and rubbed a couple of them a little againſt one another, they quickly afforded, as I expected, a rank ſmell of ſtale Urin.

That Diamonds themſelves will, by rubbing upon woollen cloaths, be made Electrical, ſeems to argue, that

even Their parts are ſet a moving: And that the Commotion reaches to the internal parts, I am the more apt to think, becauſe I have a Diamond, that, if I rub it well and luckily againſt my Cloaths, will, for a little while, ſhine or glimmer in the dark; which is the ſame Phænomenon that I elſewhere relate my ſelf to have produced in the King's larger Diamond, by giving it one brisk ſtroke with the point of a bodkin, where the Light that preſently appeared in the Gem, ſeemed not referrable to any thing ſo likely as the ſudden Commotion made in the internal parts of that peculiarly conſtituted Stone.

What a peculiar modification of motion, diſtinct from its degrees of *Impetus*, may doe in Fluid bodies, we have formerly in this Eſſay taken notice of. But perhaps it may be worth while to enquire, what kinds there are of it, and what effects they may have in the parts of Solid bodies themſelves. For I have obſerved,

ved, that though thoſe Stones that the *Italian* Glaſs-men uſe are very hard, and, if I miſremember not, have ſeveral times afforded me ſparks of fire by Colliſion; yet, by rubbing them a little one againſt another, I found, that ſuch an agitation was made in their parts, as to make them throw out ſtore of fœtid exhalations: And 'tis poſſibly to the ſtony Ingredient that Glaſs owes the Quality I have obſerved in it, and elſewhere mentioned, of emitting offenſive ſteams. And 'tis remarkable to our preſent purpoſe, that, though ſo vehement an agitation of the parts, as is given to Glaſs by Heat, when 'tis made almoſt red-hot in the fire, does not make it ſenſibly emit odours; yet barely by dextrouſly rubbing two ſolid pieces of Glaſs againſt one another, one may, in a minute of an hour, make thoſe fixed bodies emit ſuch copious ſteams as I found, not onely ſenſibly, but rankly, fœtid; though one would think thoſe ſtinking exhalations very indiſpoſed to be forced off, ſince they

were not expelled by the vehement fire, that the Glaſs long endured in the furnace where 'twas kept melted.

There are few things that ſhew better, both how the parts of Inorganical bodies communicate their vibrating motions to one another, and how brisk thoſe motions are, than that which happens upon the ſtriking of a large Bell with a Clapper or a Hammer. For though the ſtroak be immediately made but upon one part; yet the motion, thereby produced, is propagated to the oppoſite, and the ſucceſſive vibrations of the ſmall parts do, even in ſo ſolid and cloſe a body as Bell-metal, run many times round; as may appear by the durableneſs of the ringing noiſe, which ſeems plainly to proceed from the circularly ſucceſſive vibrations of the parts, which, unleſs they briskly tremble themſelves, can ſcarcely be conceived to be fitted to give the Air that tremulous motion, whoſe effect on the Ear, when the firſt and loud

loud noiſe, made by the percuſſion, is paſt, we call Ringing. And this motion of the parts of the ſounding Bell may be further argued by this, that, if the finger, or ſome other ſoft body, be laid upon it, the ſound will be checked or deaded, and much more, if a broad ſtring, though of a ſoft ſubſtance, be tied about it. And not onely an attentive Ear may often make us gueſs, that the ringing ſound is produced by a motion propagated circularly in the Bell, but this vibrating motion may ſometimes be alſo felt by the tremulous motion communicated by the trembling parts of the Bell to the finger, that is warily applied to it. That this motion paſſes in a round, from one ſide of the Bell to the other, ſeems manifeſt by the great difference of ſound, eſpecially in regard of ringing, that may be obſerved in a ſound Bell, and in a crack'd one; where yet all the matter and the former figure are preſerved, onely the intireneſs or continuity, which is neceſſary to the circu-

lation (if I may ſo call it) of the tremulous motion, is at the Crack ſtopt or hindred. And that the motion of the parts is very brisk, may be gueſſed partly by what has been ſaid already; but much more if that be true, which, not onely is traditionally reported by many, but has been affirmed to me by ſeveral Artificers that deal in Bells, who averred, as an experienced thing, That if a conveniently ſized Bell were bound about, any thing hard, with a broad ſtring, and then ſtruck with the uſual force, that it would otherwiſe bear very well; that percuſſion would break it, giving a diſorderly check to the brisk motion of the parts of the Bell, whereof ſome happening to be much more (and otherwiſe) agitated than others, the force of their motion ſurmounts that of their Coheſion, and ſo produces a Crack.

But, in regard great Bells are not eaſie to be procured, nor to be managed when one has acceſſe to them, I ſhall add, that I took the Bell of a large

large Watch, or very ſmall Clock made of fine Bell-metall, which had no handle or other thing put to it, ſave a little Bodkin or skiver of wood, whoſe point we thruſt into the hole that is uſually left in the middle of the *Baſis*; and this ſharp piece of wood ſerving for a handle to keep the Bell ſteady enough, we placed in the cavity of it, near the edges, (for that Circumſtance muſt not be omitted,) ſome black mineral Sand, or, in want of that, ſome ſmall filings of Steel or Copper, or ſome other ſuch minute and ſolid Powder, which yet muſt not be too ſmall, and then ſtriking moderately with the Key againſt the ſide of the Bell, we obſerved, (as we expected) that, whilſt it continued briskly ringing, it made many of the filings to dance up and down, and ſometimes to leap up, almoſt like the drops of Water, formerly mentioned to skip, when the brim of the Glaſs was circularly preſt by the wetted finger. Which prompts me to add, that, having put a middle-

ſized

ſized drop of water (for in this caſe the quantity is a conſiderable Circumſtance) near the lower edge of the Bell, 'twas eaſie to make it viſibly tremble, and be as it were covered over with little waves, by a ſomewhat brisk ſtroke of the Key on the oppoſite ſide. And this effect was more conſpicuous, when a very large drop of water was placed near the edge, on the convex ſide of a hand-Bell, whoſe Clapper was kept from any where touching the inſide of it. And to obviate their jealouſie, that, not having ſeen the manner of the above-mentioned motion of the Sand, might ſuſpect that 'twas produced by the impulſe which the Bell, as an intire body, received from the percuſſion made by the Key, we ſeveral times forbare putting-in the filings, till after the ſtroke had been given; which ſatisfied the Spectatours, that the dancing and leaping of the minute bodies proceeded from the ſame brisk vibrations of the ſmall parts of the Bell, which, at the ſame time

ſtriking

ſtriking alſo the Air, produced a ringing ſound, which might very well, as it did, out-laſt the skipping of the filings; the exceedingly minute particles of the Air being much more eaſily agitable, than the comparatively groſs and heavy Corpuſcles of the Powder. And this ſucceſs our Experiment had in a Bell, that little exceeded an inch and half in Diameter.

And here, *Pyroph.* I ſhall put an end to this Rhapſody of Obſervations, hoping, that, among ſo many of them, ſome or other will be able to engage you, if not to conclude, yet at leaſt to ſuſpect, that ſuch Local motions, as are wont either to be paſt-by unobſerved, or be thought not worth the obſerving, may have a notable operation, though not upon the generality of bodies, yet upon ſuch as are peculiarly diſpoſed to admit it, and ſo may have a conſiderable ſhare in the production of divers difficult *Phænomena* of nature, that are wont to be referred to leſs genuine, as well as leſs intelligible, Cauſes.

FINIS.